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Pre-season special physical and technical training model for ski racing elite

UDC 796.1

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Abstract

Objective of the study was to analyze benefits of a new special physical and technical training model for the ski racing elite applicable in the snowless training period.

Methods and structure of the study. We offered a set of special exercises mimicking the core roller skiing technique of special benefits for the technical and physical training of the ski racing elite [2-5], particularly in the snowless season. We have also analyzed some factors of special influence on the ski stride cycle speed with a special attention to the movement structure transformations with progress in the skiing techniques customizable to the track conditions. The new special physical and technical training model testing experiment was run in April to January, with the Reference Group trained traditionally and the Experimental Group trained under the special physical and technical training model with its micro-cycles. Special physical fitness tests were based on a biomechanical analysis of the snow and snowless roller skiing techniques. As was demonstrated by our prior studies, the snow technique imitation practices tend to mimic the skiing movements in general terms being largely different in the internal technical specifics. In practical tradition, they are used to improve the skiing techniques and athlete's functionality.

Results and conclusion. The snow skiing technique imitation practices tend to simulate the skiing movements in general terms being largely different in the internal technical specifics. In practical tradition, they are used to improve the skiing techniques and athlete's functionality. Our study of the ski racing technique biomechanics showed benefits of the new special physical and technical training model with micro-cycled workload management elements and roller skiing trainings in the snowless period, with a special emphasis at the precompetitive stage. The model was tested beneficial by the Experimental Group versus Reference Group progress tests on the whole and classic diagonal stride / kick double poling harmony rating tests in particular.

Keywords: *special physical training of elite racing skier, skier training process management, skier's special physical and technical fitness monitoring.*

Background. The latest competitive regresses of the national skiers and biathletes on the global arenas have urged the national sports community to develop training systems and progress management methods and tools to facilitate, among other things, the athlete-coach cooperation for success. Physical and technical competitive fitness may be defined as the product of the long-term training system with the relevant endurance building and resourcing elements and individual motor skills excellence trainings for success. Leading national experts in the sports theory and practice give a special priority to the most efficient and promising modern training systems, models and tools, with the highest attention to the mid-seasonal (snowless) physical and technical conditioning elements geared to prevent the natural regresses in the fine motor skills, movement coordination qualities and techniques [1, 2, 5]. We have analyzed in our prior studies some special training practices and training system management elements applicable in the pre-season period [1, 5].

Objective of the study was to analyze benefits of a new special physical and technical training model for the ski racing elite applicable in the snowless training period.

Methods and structure of the study. The new special physical and technical training model testing experiment was run in April to January, with the Reference Group (RG) trained traditionally and the Experimental Group (EG) trained under the special physical and technical training model with its micro-cycles. Special physical fitness tests in the experimental period were based on a biomechanical analysis of the snow skiing and snowless roller skiing techniques. As it has been demonstrated in our prior studies, the snow technique imitation practices tend to mimic the skiing movements in general terms being largely different in the internal technical specifics. In practical tradition, they are used to improve the skiing techniques and athlete's functionality.

It should be emphasized that a standard roller skiing technique was found to significantly differ from the snow skiing one in 6 of 20 test rates including 12.8% difference in the elementary movement speeds and 9% difference in the angular test rates. We offered a set of special exercises simulating the core roller skiing techniques of special benefits for the technical and physical training of the ski racing elite [2-5], particularly in the snowless season. We have also analyzed some factors of special influence on the ski stride cycle speed with a special attention to the movement structure transformations with progress in the skiing techniques customizable to the track conditions.

These individual technical transformations are generally geared to optimize the movement elements so as to achieve and maintain the highest racing speed allowed by the specific track situation, with such speed interpreted as highest best for the track conditions with no excessive fatigue for the skier. This point may be further clarified by a componential analysis of the high-speed stride. Thus a growth in the movement cadence (pace) with no change to the stride length requires a higher energy cost i.e. exposes the skier to fast fatigue. Pace growth normally results in a shorter stride and, hence, slows down the racing speed. Therefore, a high-speed movement sequence shall be strictly balanced in its elements, and this is the reason why the skiing technique excellence trainings give such a high priority to the movement harmony indicator that may be defined as the stride length to stride frequency ratio: see Table 1.

Table 1. *Classic diagonal stride technique harmony ratios of the ski racing elite on plain tracks*

№	Track conditions	Harmony ratio
1	Excellent	2,35
2	Good	1,70
3	Thaw	1,46
4	Mushy track	1,42

The EG techniques with the movement speed elements were tested for classical diagonal and kick double poling strides as statistically dominant in the modern sport. The stride harmony ratios were calculated based on analysis of the pre- versus post-experimental competitive performance video captures.

Results and discussion. The experimental data analysis found significant differences in the EG and RG progress in the movement harmony ratios. The pre-experimental tests (in March) found the intergroup classic diagonal stride harmony difference insignificant at 1.59 and 1.61 in the EG and RG, respectively, with RG being 1.2% ahead. The mid-experimental (December) classic diagonal stride harmony test found falls of 1.8% and 7.2% and absolute values of 1.56 and 1.49 in the EG and RG, respectively, with the 4.2% advantage of the EG. And the post-experimental (late January) classic diagonal stride harmony tests found progress of 6.6% (to 1.67) and 1.8% (to 1.52) in the EG and RG, respectively – with the RG rated 9.0% under the optimal classic diagonal stride harmony ratio. On the whole, the EG was tested to make progress of 4.9% versus the RG regress of 5.5% on the harmony ratio scale: see Table 2.

Table 2. *Group classic diagonal stride harmony ratio test data: pre-, mid- and post- experimental tests (1, 2 and 3) (X±S)*

Group	Classic diagonal stride harmony ratio		
	Test 1	Test 2	Test 3
EG	1,59±0,15	1,56±0,12	1,67±0,1
RG	1,61±0,12	1,49±0,15	1,52±0,13
p	>0,05	<0,05	<0,05

Much the same progress was found on the kick double poling stride harmony ratio test scale: see Table 3. The pre-experimental tests rated the EG and RG kick double poling harmony ratio at 1.56 and 1.62 on average, respectively, with 3.8% advantage of the RG. The mid-experimental test in December rated the EG and RG kick double poling harmony ratio at 1.49 and 1.43 (3.7% different), with the falls of 4.1% and

11.6%, respectively. And the post-experimental test in February found the EG kick double poling harmony ratio to grow by 8.6% to the optimal value of 1.63 – versus the 5.5% growth in the RG (still 6.8% under the optimal value).

Therefore, the tests found the classic diagonal stride / kick double poling harmony ratios in the EG to slightly fall in the mid-time and then reach the optimal level by the season (January) and stay at this level till February. The RG was tested with a significant fall of the harmony ratio at the end of regular season with a small rise in the early season.

Table 3. *Group kick double poling stride harmony ratio test data: pre-, mid- and post- experimental tests (1, 2 and 3) (X±S)*

Group	Classic diagonal stride harmony ratio		
	Test 1	Test 2	Test 3
EG	1,56±0,12	1,49±0,14	1,63±0,08
RG	1,62±0,13	1,43±0,17	1,52±0,14
p	>0,05	<0,05	<0,05

On the whole, the systemic and harmonized training system with regular progress tests in the training and competitive process was found to facilitate special physical fitness building on a sound technical test basis. It should be emphasized that in every training cycle the coaches shall closely test progress and stress tolerances, with the costs and benefits of every training session closely and prudently managed in the pre-season prior to the major events.

Conclusion. Our study of the ski racing technique biomechanics showed benefits of the new special physical and technical training model with micro-cycled workload management elements and roller skiing trainings in the snowless period, with a special emphasis in the pre-season. The model was tested beneficial by the EG versus RG progress tests on the whole and classic diagonal stride / kick double poling harmony rating tests in particular.

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Harmonized physical and technical training model for swimming sport elite tested in basic training mesocycle

UDC 797.212.4

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Abstract

Objective of the study was to rate benefits of the new movement biomechanics prioritizing harmonized physical and technical training model for the swimming sport elite.

Methods and structure of the study. We used in the study a set of the swimming process video capturing and analyzing methods with dynamometric tools provided by a SwimForceTest computerized test system, with the test data processed by a standard statistical toolkit. We sampled for the new physical and technical training model testing experiment timed to a 6-week basic training mesocycle elite swimmers (n=26) qualified CMS, MS and WCMS; and split them up into Experimental and Control Groups (EG, CG) of 13 people each. The CG was trained in the traditional training system, and the EG training was dominated by the movement biomechanics prioritizing new harmonized physical and technical training model.

Results and conclusions. The new movement biomechanics prioritizing harmonized physical and technical training model for the swimming sport elite was tested beneficial as verified by the significant progress made by the EG in many tests versus the traditionally trained Control Group.

Keywords: *physical and technical training, swimming sport elite, synergy, combined training tools, mesocycle.*

Background. Modern training system may be defined as the harmonized sequence of training tools and components designed and managed so as to ensure the fastest technical and tactical progress. The training system designer shall prudently balance the training system elements by the scopes and intensities with due consideration for their potential positive and negative interactions. Thus an excess of the physical training elements in the swimming elite training system is known to be potentially detrimental to the technical growth and competitive progress of the swimmers [2]. On the other hand, when the training system is well designed and managed to ensure due synergy of the training tools, the resultant progress may be much higher than when these tools are applied altogether with little attention to their sequencing, harmony and synergy [5].

As far as the range of possible correlations and mutual influences of the training components and tools are concerned, they may unlikely be covered herein, although it should be emphasized that the research community gives a special priority to the physical and technical training elements as the key in any training cycle [2-4]. It should also be mentioned that the existing study reports on the physical and technical training elements integration in the training systems show that these issues are still underdeveloped and deserve a special attention of sport specialists.

Objective of the study was to rate benefits of the new movement biomechanics prioritizing harmonized physical and technical training model for the swimming sport elite.

Methods and structure of the study. We used in the study a set of the swimming process video captur-

ing and analyzing methods with dynamometric tools provided by a SwimForceTest computerized test system, with the test data processed by a standard statistical toolkit. We sampled for the new physical and technical training model testing experiment timed to a 6-week basic training mesocycle elite swimmers (n=26) qualified CMS, MS and WCMS; and split them up into Experimental and Control Groups (EG, CG) of 13 people each. The CG was trained in the traditional training system, and the EG training was dominated by the movement biomechanics prioritizing new harmonized physical and technical training model. The gym trainings were assisted by a VASA ERGOMETER training machine that helps closely simulate (as stated by the manufacturer) aquatic swimming motor skills; plus KINESIS and VASA Trainer simulators. The gym trainings with simulators took at least 40% of the total training time in the EG, and aquatic practices – at least 30%, with the actual proportions dictated by the mesocycle-specific training goals.

Results and discussion. Striving to find the best movement biomechanics harmonizing points in the physical and technical training toolkit, in the EG training system we gave a special priority to the gym and aquatic practices of special benefits for the physical and technical training harmonizing and synergizing purposes. The physical and technical training tools were selected, among other things, in view of the aquatic and on-land stroke power test rates versus the stroke kinematics. The individual physical and technical training progress was facilitated by special technical equipment and accessories including a range of rubber bands (applied ashore and in water), hand blades of different sizes, stroke technique excellence tools with weights and training intensity controls, and the above mentioned KINESIS, VASA Ergometer and VASA Trainer machines.

We have analyzed in a prior study similarities in the movement kinematics and physical parameters of the aquatic swimming techniques versus that on the VASA Ergometer simulator [1]. Herein we used the prior findings to find the closest correlations between the on-land and aquatic technical parameters including the momentary stroke power in the pull phase, momentary strength in the pull phase and thrust phase on land; and the hand movement speed and accelera-

Table 1. *Pre- versus post-experimental test data of the EG and CG, M±m*

Test rates	EG, n=13		CG, n=13	
	Pre-exp.	Post-exp.	Pre-exp.	Post-exp.
Stroke length, m	**1,92** ±0,01	**2,12** ±0,05 t=2,19 p<0,05	**1,91** ±0,06	**1,94** ±0,11 t=1,99 p>0,05
Pace, moves per min	**54** ±2,12	**48** ±1,27 t=2,25 p<0,05	**52** ±2,12	**46** ±2,42 t=2,54 p<0,05
Hand move time in pull phase, s	**0,29** ±0,04	**0,37** ±0,01 t=2,19 p<0,05	**0,29** ±0,05	**0,29** ±0,03 t=1,84 p>0,05
Hand move time in thrust phase, s	**0,17** ±0,02	**0,25** ±0,01 t=2,63 p<0,05	**0,18** ±0,01	**0,19** ±0,02 t=2,07 p>0,05
Momentary stroke power in pull phase, W	**123,25** ±1,25	**139,52** ±2,57 t=2,38 p<0,05	**124,52** ±3,29	**127,29** ±9,07 t=2,01 p>0,05
Momentary stroke power in thrust phase, W	**223,01** ±2,02	**281,71** ±7,01 t=2,84 p <0,05	**239,01** ±8,37	**253,04** ±6,99 t=1,89 p>0,05
Total aquatic pull strength, kg/ s	**189,24** ±0,57	**199,67** ±2,01 t=2,59 p<0,05	**175,62** ±9,44	**179,11** ±5,77 t=1,98 p>0,05

tion in the pull and thrust phases in water (r≥0.78; p <0.01): see Figure 1.

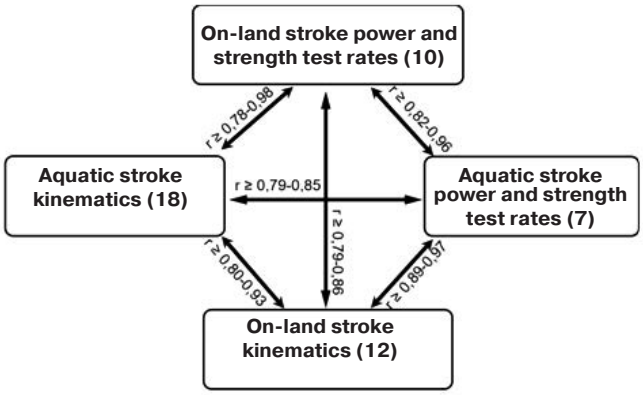

Figure 1. *Correlations of the physical and technical training elements in the new training model*

Note: numbers of test rates in brackets, p<0.01

The correlations give the reasons to believe that these physical and technical training tools are well synergized. A comparative analysis of the pre- versus post-experimental kinematic/ dynamic tests rates of the EG and CG showed benefits of the new model: see Table 1.

As demonstrated by the above Table, the CG has made insignificant progress in the stroke length that cannot be interpreted as technical progress – versus the EG test rates that were indicative of a significant technical progress on this test scale; with both groups tested with a significant fall in the movement paces. Note that the inverse correlation of the stroke length with pace (indicative of the swimming technique quality and efficiency) was found only in the EG. Furthermore, our analysis of the technique kinematics using the computer video analyzing method found a significant progress in the EG in the duration of the key movement phases (pull and thrust phase) – versus an insignificant CG progress in the thrust phase only (p> 0.05).

Having analyzed the physical fitness test rates, we found that the purposeful training of the stroke phase by the combined on-land plus aquatic physical and technical training tools has resulted in the significant growth of the momentary stroke power in pull phase in the EG – versus insignificant progress in the CG. Since the stroke power directly contributes to the total aquatic thrust, the EG was tested with a significant progress in this test rate as well: see the Table. The significant progress of the EG in the propulsion strength elements may be interpreted as secured by the new harmonized on-land plus aquatic physical and technical training model. The traditional training system in the CG was found to secure insignificant progress in the tested physical qualities (p> 0.05).

As far as the spatial and temporal parameters of the swimming technique are concerned, it should be noted that the swimming speed heavily depends on the hand speed and acceleration in every phase of the stroke sequence. The EG hand speed in the thrust and pull phase was tested to grow by 32% and 12% versus 7% and 2% in the CG, respectively, for the experimental period; whilst the hand acceleration rate was tested to grow in the pull and thrust phase by 25% and 30% versus 5% and 5% in CG, respectively. The progress may be interpreted as indicative of the stroke power growth with development of the so-called whip effect in the technique that is known to contribute to the swimming speed. No wonder that the EG made progress in the average competitive speed from 1.95±0.03 m/s to 2.06±0.01 m/s (p <0.05) versus 1.96±0.02 m/s to 1.97±0.01 m/s (p> 0.05) in the CG.

Conclusion. The new movement biomechanics prioritizing harmonized physical and technical training model for the swimming sport elite was tested beneficial as verified by the significant progress made by the EG in many tests versus the traditionally trained CG.

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Starting double- and triple-support pulls in mas-wrestling: skeletal muscle electrical activity rating emg tests and analysis

UDC 796.012

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Abstract

Objective of the study was to run electromyographic (EMG) tests of the key muscle group electrical activity in the starting triple – and double-support pull versions with a comparative analysis.

Methods and structure of the study. We made, for the purposes of the study, EMG tests of the key muscle groups mobilized in the starting triple- and double-support pull versions in the mas-wrestling bouts using a computerized EMG test system [4, 6, 5]. The muscle group electrical activity was tested using a standard Muscle Lab system made by Ergotest Technology Co.

Results and conclusions. Presently the starting triple – and double-support pulls are the key pull techniques in the modern mas-wrestling sport of special benefits for competitive success, with both of the techniques mobilizing specific and somewhat different muscle groups as verified by the muscle electrical activity test rates yielded by the EMG tests, with a range of individual muscle group mobilization and control differences.

In the horizontal pull move, tested with the highest amplitudes, integrated electrical activity and EMG frequency was the trapezius muscle – that is the lead trunk muscle in the case. The latissimus and lumbar extensor muscles were tested with the lower electrical activity. It should be noted that the trunk muscles were mobilized first for the pull and relaxed the last thereafter.

Tested with the highest amplitudes, integrated electrical activity and EMG frequency in the starting double-support pull sequence was the radial hand flexor ranked as the lead muscle in the case.

On the whole, the study data and analyses showed the individual choice of a starting triple- and double-support pull technique being largely dictated by the lead muscle group power fitness and control rates and the specific tactical goals in one or another bout.

Keywords: *mas-wrestling, athletes, triple /double-support pull, electromyographic test system, muscle group.*

Background. Success in the modern mas-wrestling sport competitions depends on the specific technical and tactical skills, with the starting pulls generally classified into the triple- and double-support ones – that mean the preferred starting positions. The individual starting preferences are believed to be dictated by the fine biomechanics, muscle group power and fitness and specific priority goals of every bout. It is not unusual that an individual standard starting posture heavily contributes to the competitive success [1, 3, 6, 7].

The starting pull and potential immediate advantage it generates is secured by the lead muscle groups of the upper and lower limbs and trunk – conditional on the perfect harmony and coordination of skeletal muscle efforts for the highest efficiency of the muscle contraction process [2, 3, 8]. It should be emphasized, however, that the sport is still in need of the key muscle group performance rating studies and analysis, with a special priority to the starting triple- and double-support pull versions applied in mas-wrestling bouts.

Objective of the study was to run electromyographic (EMG) tests of the key muscle group electrical activity in the starting triple- and double-support pull versions with a comparative analysis.

Methods and structure of the study. We made, for the purposes of the study, EMG tests of the key muscle groups mobilized in the starting triple- and double-support pull versions in the mas-wrestling bouts using a computerized EMG test system [4, 6, 5]. The muscle group electrical activity was tested using a standard Muscle Lab system made by Ergotest Technology Co. The computerized test system of a modular telemetric design may be configured and customized for specific research goals. The MuscleLab test system includes a 8-channel electromyograph; a 1D/ 2D/ 3D goniometer module; dynamometric 2-channel module rated for 100kg, 300kg and 500kg maximums; a connector port for the power platform; chronometric module with up to 8 optic couples; a contact mat for IR tests; biaxial accelerometer; and a linear movement sensor with an inertial coil to fix positions and linear movement speeds. In practical EMG tests, we used disposable surface electrodes fixed on skin 2cm afar. We tested the trunk/ lower limb muscle group electrical activity in the starting triple- and double-support pull versions of the mas-wrestling bouts. More specifically, we tested the electrical activity of the trunk trapezius muscle, latissimus dorsi, and lumbar extensor muscles; and the lower limb quadriceps, biceps and gastrocnemius.

Results and discussion. Given on Figure 1 hereunder are the starting triple- and double-support pull test data that made it possible to detect the lead muscles in the movement sequence.

In the horizontal pull move, tested with the highest amplitudes, integrated electrical activity and EMG frequency was the trapezius muscle (± 495.36 μVs; 124.4±8.09 Hz) – that is the lead trunk muscle in the case. The latissimus and lumbar extensor muscles were tested with the lower electrical activity. It should be noted that the trunk muscles were mobilized first for the pull and relaxed the last thereafter.

Furthermore, we tested the lower limb muscle electrical activity in the starting triple-support pull sequence to find the biceps femoris electrical activity lower than in the trunk muscles albeit higher than in the other lower limb muscles. The lead and assisted muscles were tested to mobilize sooner and stay active later in the starting triple-support pull sequence than the other muscles: see Figure 1.

Then we tested the above muscle electrical activity in the starting double-support pull sequence to find the lead muscle group: see Figure 2. We found the static posture-specific angular characteristics of the trunk, lower limbs and forearms, plus the knee extension range varying from 100° to 180° (see Figure 2) with active contraction of the trapezius muscles.

Tested with the highest amplitudes, integrated electrical activity and EMG frequency in the starting double-support pull sequence was the radial hand flexor (332.87±95.6 μV; 1413.5±495.36 μVs; 124.4 ± 8.09 Hz, respectively) ranked as the lead muscle in the case. It should be noted that the triceps brachii and biceps femoris were tested with the lower electrical activity albeit higher than in the other muscles (see Figure 2). The lead and assisted muscle group were tested to mobilize sooner and stay active later in the starting double-support pull sequence than the other muscles.

Figure 1. *EMG test data for the starting triple- and double-support pull movement sequence*

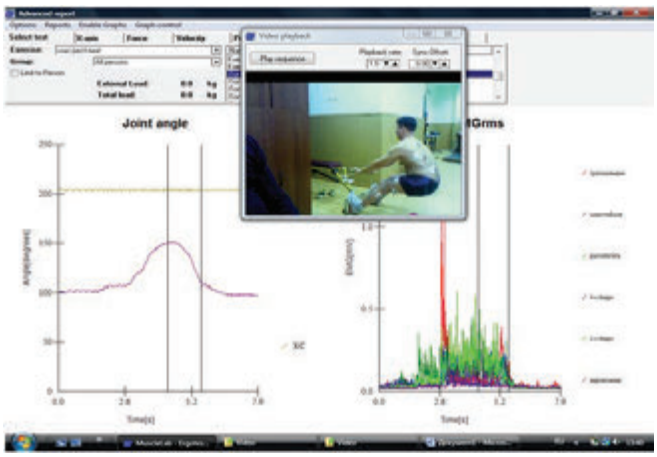

Figure 2. *EMG test data for the starting double-support pull movement sequence*

Therefore, the specific horizontal pull execution technique (triple- and double-support pulls) was found to mobilize and load somewhat different muscle groups and bodily elements. As demonstrated by the above study data, the triple- and double-support pulls mobilize different muscle groups and skeletal muscles due to the natural differences, benefits and drawbacks of every pull technique plus the individual preferences of the athletes.

Conclusion. Presently the starting triple- and double-support pulls are the key pull techniques in the modern mas-wrestling sport of special benefits for competitive success, with both of the techniques mobilizing specific and somewhat different muscle groups as verified by the muscle electrical activity test rates yielded by the EMG tests, with a range of individual muscle group mobilization and control differences. On the whole, the study data and analyses showed the individual choice of a starting triple- and double-support pull technique being largely dictated by the lead muscle group power fitness and control rates and the specific tactical goals in one or another bout.

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Group routine synchronizing model for rhythmic gymnastics

UDC 796.012

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Abstract

Objective of the study was to complement and improve the group rhythmic gymnastics training system by a group routine synchronizing model with special technical and physical training elements.

Methods and structure of the study. We used for the purposes of the study a contactless routine video replay analyses; postural control rating stabilometric Stabilan-01 digital test platform; skin electromyography testing 16-channel MegaWin ME 6000 electromyograph; training system design methods, expert valuations, new training model testing experiment; and the standard test data processing mathematical statistics toolkit. We sampled for the prior movement biomechanics study 21 year-old Masters of Sport (n = 2) from Lesgaft National State University, St. Petersburg champions and many-times winners of the national and international group rhythmic gymnastics events. The sample for the model testing experiment was complemented with the Lesgaft National State University team members (n = 5).

Results and conclusions. Statistical analysis of the movement synchronizing elements showed the group movement synchronizing fault rate to significantly fall for the experimental period, with special improvements in the group collaborations due to a significant progress in the individual motor skills and synchronized performance quality on the whole.

The study with the new group routine synchronizing model testing experiment found that the objective movement biomechanics test data and movement synchronizing difficulty classification analyses provide a sound basis for progress in the group rhythmic gymnastics routine synchronizing aspects. The new group routine synchronizing model was designed based on the movement synchronizing difficulty rating algorithm with the relevant stepped movement synchronizing training modules and training process goals to facilitate progress in the movement synchronizing teamwork and the relevant technical and physical training aspects for success in the synchronized group routines with the difficulty levels stepped up with progress in the movement synchronizing skills and experience.

Keywords: *rhythmic gymnastics, group routine, movement biomechanics, synchronization difficulty factors.*

Background. Harmonious artistic imaging (body expression) goals in modern competitive group rhythmic gymnastics routines are attainable only when a special priority is given to movement synchronizing in amplitudes, timing and pacing aspects to demonstrate perfect teamwork in every collaboration, dance step sequence, rolling, tossing, exchange and other elements [1, 3, 5]. In view of the highest competitiveness of the modern group rhythmic gymnastics sport, every single fault, no matter how all it may be, may snowball in group asynchrony and, hence, low technical scores and final places. This is the reason why so high priority is given to group performance synchronizing in the modern group rhythmic gymnastics training systems [2, 5].

Objective of the study was to complement and improve the group rhythmic gymnastics training system by a group routine synchronizing model with special technical and physical training elements.

Methods and structure of the study. We used for the purposes of the study a contactless routine video replay analyses; postural control rating stabilo-

metric Stabilan-01 digital test platform; skin electromyography testing 16-channel MegaWin ME 6000 electromyograph; training system design methods, expert valuations, new training model testing experiment; and the standard test data processing mathematical statistics toolkit. We sampled for the prior movement biomechanics study 21 year-old Masters of Sport (n = 2) from Lesgaft National State University, St. Petersburg champions and many-times winners of the national and international group rhythmic gymnastics events. And we complemented the sample for the model testing experiment by the Lesgaft National State University team members (n = 5).

Results and discussion. Having analyzed the movement kinematics with the electromyography test data, we found the group routine synchronizing in every element heavily depending on the elementary skill difficulty level, with a special training required to secure due movement synchronizing in the group. We have analyzed the expert synchronization difficulty scores for every element of the routine versus the kinematic consistency and the muscle electrical activity (electromyography) test rates. We found the synchronizing quality being dependent, among other things, on the visual control of the movement spacing, timing and pacing, with a special attention to the movement asynchrony not only in the joint angles but in the limb/ trunk and other bodily parts movement speeds.

As found by a correlation analysis, due synchronizing of the joint angles and movement amplitudes will be secured by the key muscle group activation mechanisms, with the movement synchronizing quality secured by the muscle electrical activity being correlated with the joint angle controls. Furthermore, we have found that the Masters of Sport in every collaboration, dance stepping etc. phase implies every individual execution being accurately paced and timed for the group synchronizing, with the synchronizing difficulty level determined by the positioning specifics (in congested or free settings, back/ side/ frontal to each other etc.), and the relevant execution difficulties. Thus, elliptical postural control spots produced by the stabilographic tests and indicative of the body balance variability range in the Masters of Sport process were found to significantly degrade ($p < 0.05$) after 20s high-intensity dynamic training, with the movement synchronization sagging by 30%.

The postural control and body spacing, timing and pacing difficulties were also found to depend on the apparatus handling skills and natural lead (right or left) hand control specifics in the teamwork. It should be emphasized that the apparatus control skills in the context of the body balancing and routine synchronizing aspects should be ranked high among the other Masters of Sport complicating factors and be addressed by the relevant focused movement synchronizing training elements in the rhythmic gymnastics training system [3, 4].

Knowing that the movement synchronizing in rhythmic gymnastics is secured by perfect timing and pacing of the routine phases, periods and elements harmonized with the musical illustrations, we analyzed the range of kinematic disorders in the varied-pace movement synchronizing – to find that they generally arise from inability to maintain the optimal paces and accelerations of the key bodily parts within the tempo-rhythmic structure of the group routine. Therefore, a special priority in the group routine synchronizing model was given to the individual mastery in pacing and timing the synchronized movements and their combinations for success of the technical training. It may be stated with confidence that an optimal technical and physical fitness achieved by the group routine synchronizing training and progress in the team movement pacing and harmonizing skills help scale down the fault rates in the group routine synchronization aspects [1, 2]. Therefore, the Masters of Sport difficulty factors classified based on the movement biomechanics analyses were used as a basis for the movement synchronizing training with the technical and physical fitness elements in the new group routine synchronizing model: see Figure 1.

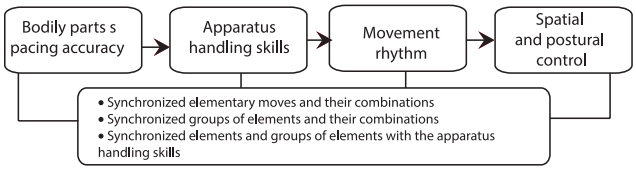

Figure 1. *Summarized synchronized movement excellence algorithm for the group routine synchronizing model*

The training system in the group routine synchronizing model testing experiment was designed and managed using the following specific training modules to achieve the technical and physical fitness standards for the group routine synchronizing purposes. Module 1 was designed to improve the spatial group movement control with perfectly harmonized muscular efforts in every movement element and sequence. The module set forth a sequence of training goals starting from the elementary limb movements mastering components and up to the specific sequences/ combinations from the rhythmic gymnastics routine.

Module 2 was designed to improve the apparatus handling skills with a special attention to the body balancing (postural control), spacing, timing and pacing aspects for every bodily part. The module offers sets of special apparatus handling exercises – from the elementary individual skills mastering ones to the exchanges, tosses and difficult group combinations.

Module 3 made a special emphasis on the group rhythm excellence aspect with the perfect key muscle group activation, control and timing. The Module 1 and 2 exercises were practiced in Module 3 with a metronome to control the execution pace – from the slow to moderate and then combinations of controlled moderate-to-slow, moderate-to-fast, slow-to-fast etc. sequences to improve the teamwork.

And Module 4 was intended to excel the spatial/postural control with body balancing skills under varied-intensity workloads, with the above three module exercises used in (1) different combinations and aspects; (2) in every movement sequence; and (3) under stepped-intensity workloads.

The above described group routine synchronizing model was tested in the Lesgaft National State University group rhythmic gymnastics team training system, with the team progress tested by the synchronizing faults rating pre- versus post-experimental tests in the annual training cycle: see Table 1 hereunder.

Table 1. *The Lesgaft National State University group rhythmic gymnastics team: pre- versus post-experimental faults in a 5-hoop routine*

№	Synchronizing rating criteria	Pre-exp.	Post-exp.
1	Arm work in the BDs	6	3
2	Footwork in the BDs	4	3
3	Collaborations	4	0
4	Dance step combinations	6	1
5	Throws in exchanges	4	2
6	Catches in exchanges	5	3
7	Apparatus handling in the dance step combinations	7	3
8	Footwork in the dance step combinations	6	2
9	BD startup	4	3
10	BD completion	5	3
Total faults (54,91% reduction)		51	23

Note: BD body difficulties in the gymnastics routine

Statistical analysis of the movement synchronizing elements showed the group movement synchronizing fault rate to significantly fall by 54.91% ($p < 0.05$) for the experimental period, with special improvements in the group collaborations due to a significant progress in the individual motor skills and synchronized performance quality ($p < 0.05$) on the whole.

Conclusion. The study with the new group routine synchronizing model testing experiment found that the objective movement biomechanics test data and movement synchronizing difficulty classification analyses provide a sound basis for progress in the group rhythmic gymnastics routine synchronizing aspects. The new group routine synchronizing model was designed based on the movement synchronizing difficulty rating algorithm with the relevant stepped movement synchronizing training modules and training process goals to facilitate progress in the movement synchronizing teamwork and the relevant technical and physical training aspects for success in the synchronized group routines with the difficulty levels stepped up with progress in the movement synchronizing skills and experience.

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From theory to practice – rapid assessment of combat athletes somatotypes using computer technologies

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Abstract

Objective of the study was to analyze the features of the physique and to give rapid assessment of the somatotype of combat athletes using computer technologies in the groups of Russian and Altai men.

Methods and structure of the study. Morphological characteristics (20+ measurements and indices of body proportions) were investigated in four groups of Russian and Altai males from 18 to 31 years of age (N=348): two groups of Russian and Altai combat athletes (mostly different kinds of wrestling) of high qualification and two control groups of Russian and Altai males not involved in professional sports. For somatotype evaluation the method of the American anthropologists B. Heath and L. J. Carter (with an assessment of endo-, meso- and ectomorphy) and the typology of V.E. Deryabin (based on factor analysis of body dimensions with the calculation of indicators of micro / macrosomia, shoulder breadth, muscle development and general adiposity) were used.

Results. Specific body proportions in combat athletes, typical of both ethnic groups, were revealed: broad chest, broad shoulders, relatively short legs and long arms, minimal development of subcutaneous fat layer on the body and limbs. When comparing the distribution of somatotypes according to the Heath-Carter method, the examined athletes are characterized by a pronounced mesomorphic bodybuild, and the representatives of the control groups are characterized by the dominance of mesomorphic-endomorphic somatotypes. The distribution of body build types according to Deryabin scheme showed well-developed muscles and a pronounced broad shoulders, in combat athletes, while in individuals from the control groups - an opposite combination of traits and a relatively increased fat component. Conclusion. The somatotyping methods of Heath-Carter and Deryabin, tested on Russian and Altai groups of combat athletes, adequately reflect the physique features of athletes and allow using computer technologies to carry out a quick and objective individual express assessment of the somatotype with the possibility of visualizing the results of somatotyping on a graph. Heath-Carter and Deryabin's somatotyping method can be recommended as additional criteria for assessing the physical condition of athletes, the choice of wrestling styles, as well as for the sports selection of young candidates.

Keywords: *combat sports, anthropometry, somatotype, classifications of human physique, morphological characteristics*

Introduction. One of the current problems in the development of modern sports is the search for the best ways and means to achieve outstanding sports results at the lowest cost of time and efforts of athletes and coaches, while maintaining a high level of health and harmonious development of those involved. To solve this problem, it is important to have an objective assessment of the somatotype of athletes in order to adjust the intensity and volume of training and competitive loads, as well as for the selection of young candidates [1-2, 9-11]. Despite a large number of publications dealing with the morphological characteristics of athletes in different kinds of sports [3, 9, 11], the physique of combat athletes was much less analysed, especially in the national scientific literature [1, 6, 8]. Accumulation of information about somatotypes of athletes of different specializations will reveal predictors of competitive success, improve the effectiveness of sports selection and adjust the training process in a timely manner. In this regard, **the aim**

of the research was to study the morphological characteristics of combat athletes and to give a rapid assessment of their somatotypes based on two modern physique classifications using computer technologies in groups of Russian and Altai men.

Methods and organization of the research. The materials of a comprehensive anthropometric survey of combat athletes engaged mainly in different types of wrestling, of Russian and Altai ethnicity (48 and 106 individuals correspondingly) 18-31-year-old, as well as two groups of men, who were not engaged in professional sports (the control groups - 97 individuals of Russian and 97 individuals of Altai ethnicity), were used for this study. The control groups were as close as possible in age and distribution of individuals with different weight categories to the corresponding (by ethnicity) groups of combat athletes. The anthropometric programme included measurements of height and weight; corpus and limbs lengths; shoulder and pelvic breadths; chest, upper arm, forearm and foreleg circumferences; elbow and knee widths; subscapular, abdomen and triceps skinfolds. All materials were collected in compliance with bioethical procedure, signing of informed consent protocols and depersonification of data. To determine the type of physique, a method of American anthropologists B.Heath and L.J. Carter [7] and a scheme of domestic anthropologist V.E. Deryabin [4] were used. For the individual assessment of the somatotype according to the Heath-Carter method, the values of endo-, meso- and ectomorphy were calculated basing on the values of ten body dimensions: endomorphy reflects the development of adipose tissue (the extreme endomorphic somatotype is characterized with increased fat develoment); mesomorphy describes the degree of musculoskeletal development (the extreme variant of this component is observed in the athletic type); ectomorphy indirectly reflects the increase in the surface body area (its maximum manifestation corresponds to the asthenic somatotype).

To assess the characteristics of the physique according to the Deryabin scheme, factor analysis of nine body dimensions was carried out. As a result individual values of typological indicators, describing the total skeletal size, body proportions, development of muscles and adiposity were obtained. One of the advantages of the use of the Heath-Carter and Deryabin methods, along with an objective assessment of the physique diversity is the ability to visualize the results of somatototyping on a graph with three axes, corresponding to the development of the most significant components of the physique. For the statistical analysis parametric and non-parametric methods were used in the Statistica 10.0 software package.

Results and discussion. The results of a comparative analysis of physique indicators in the observed groups of men are given in the Table. A stable set of traits typical for athletes, both of Russian and Altai ethnicity was revealed compared to the respective control groups: broad strong chest, broad shoulders, relatively long arms and short legs and minimal development of subcutaneous fat layer. The resulting complex of morphological features, in all likelihood, contributes to professional success in this sports specialization [5-6, 8].

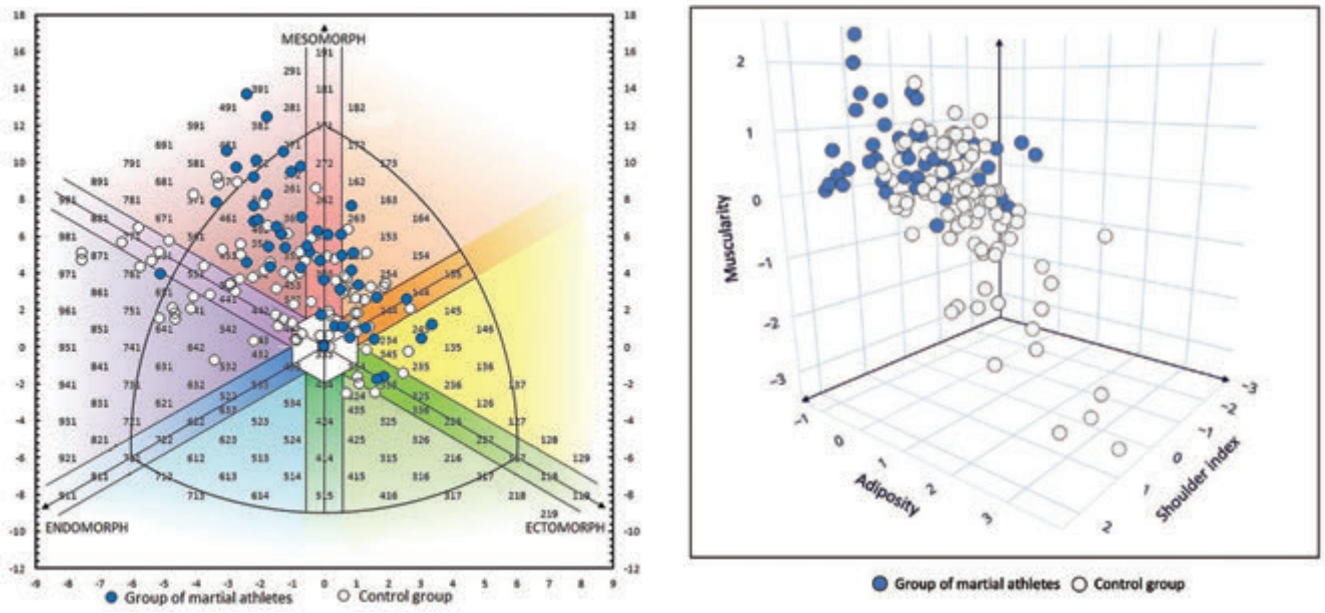
The results of the rapid assessment of somatotypes and their location in the coordinates of Heath-Carter and Deryabin schemes are presented in Figures 1-2. The groups of Russian men were taken as an example. Similar results were obtained for the Altai groups.

Table. *Morphological characteristics in the studied male groups (M ± m)*

Physique indicators	Combat athletes, Russian males (n = 48)	Control group, Russian males (n = 97)	Combat athletes, Altai males (n = 106)	Control group, Altai males (n = 97)
Age, years	20,62±0,43	20,19±0,29	24,6±0,48	24,21±0,55
Height, cm	174,88 ± 0,94*	177,91 ± 0,58	169,11 ± 0,59**	171,02 ± 0,65
Chest circumference, cm	95,15 ± 0,88	93,63 ± 0,68	91,90 ± 0,58	89,65 ± 0,78
Upper arm circumference, cm	31,45 ± 0,31*	30,58 ± 0,31	30,76 ± 0,26**	29,42 ± 0,34
Chest circumf/height, %	54,45 ± 0,45*	52,66 ± 0,40	54,37 ± 0,32**	52,43 ± 0,41
Pelvic breadth/shoulder breadth, %	69,30 ± 0,60	69,37 ± 0,39	69,23 ± 0,37**	71,32 ± 0,38
Arm length/height, %	44,82 ± 0,19*	44,19 ± 0,12	45,00 ± 0,16**	44,52 ± 0,11
Leg length/height, %	56,52 ± 0,26	56,92 ± 0,14	56,29 ± 0,12	56,33 ± 0,13
Elbow breadth/height, %	3,92 ± 0,07	4,02 ± 0,02	4,05 ± 0,05	4,15 ± 0,03
Knee breadth/height, %	5,71 ± 0,06*	5,56 ± 0,02	5,68 ± 0,03	5,71 ± 0,04
Subscapular skinfold, mm	9,47 ± 0,52*	13,17 ± 0,76	9,99 ± 0,34	9,69 ± 0,40
Abdomen skinfold, mm	8,76 ± 0,59*	16,96 ± 1,06	10,99 ± 0,68	12,86 ± 0,80
Triceps skinfold, mm	5,43 ± 0,43*	10,50 ± 0,59	5,13 ± 0,20**	8,49 ± 0,40

*Note: * – p<0,05 significant when the Russian groups are compared;*

*** – p<0,05 significant when the Altai groups are compared.*



Figs. 1-2. *Results of rapid assessment of somatotypes and their location in the coordinates of the Heath-Carter (left) and Deryabin (right) schemes in the studied groups of Russian males*

When the distribution of somatotypes according to the Heath-Carter method was compared, it was found that the studied athletes had a pronounced mesomorphic type of physique, while in the control groups dominance of mesomorphic-endomorphic somatotypes was revealed. The distribution of physique variants according to the Deryabin scheme showed in the athletes pronounced broad shoulders along with good muscle development, while males from the control groups demonstrated the opposite combination of traits and relatively increased adiposity.

Conclusion. Tested on the Russian and Altai groups of combat athletes, the physique evaluation methods of Heath-Carter and Deryabin adequately reflect morphological characteristics of the athletes and allow using computer technology to carry on a rapid and objective individual rapid assessment of the somatotypes with the possibility of visual representation of the somatotyping results on the graphs. Both physique schemes can be recommended as additional criteria for assessing the physical condition of athletes, choosing styles of fighting, and young prospective candidates in the sports selection.

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Comparative analysis of main technical characteristics of elite hurdlers (men and women)

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Abstract

Objective of the study. To compare the main spatiotemporal and angular parameters of the technique of elite hurdlers (men and women)

Methods and structure of the study. This article analyzes the spatiotemporal and angular characteristics of running technique and hurdling by the finalists of the World Championships 2017 (London) in 110 m hurdles (man) and 100 m hurdles (women). The study used data from the IAAF Biomechanical Reports [2,3] and Statgraphics plus 5.0 for data processing.

Results and conclusions. The research shows statistically significant differences between men and women observed in the take-off and landing distances and the hurdle flight time in the hurdle clearance phase. While running between hurdles, the length and flight time of the first step in women is greater ($p<0,001$), and the length of the second step is shorter ($p<0,05$). The trunk-thigh angle at toe-off during the take-off phase and the lead leg knee angle at touchdown in the two groups also differ ($p<0,05$). Many of the studied parameters have a significant range of values: in women, the lead leg knee angle (53-90°) and the trail leg knee angle (141-173°) during the take-off phase, the trunk angle at touchdown (48-64°) and toe-off during the landing step (63-78°); in men - the trunk-thigh angle during the take-off phase (53-82°) and the lead leg knee angle at touchdown (150-177°).

Keywords: *hurdling technique, biomechanical analysis, short hurdle events.*

Introduction: Hurdling is a technical type of athletics, in which the result is determined by both well-developed physical qualities, primarily speed-power, and motor skills, namely the technique of overcoming hurdles and running between hurdles. Different rules of competition for men and women hurdlers (height and placement of hurdles, distance length) and differences in anthropometrical data place specific requirements on the choice of training means [1].

The study and comparative analysis of the technical skill of the world's leading athletes allows us to model and form the optimal technique for motor actions when training athletes at various levels. In our work, the main spatiotemporal and angular parameters of the technique of clearing and running between hurdles were studied.

Objective of the study. To compare the main spatiotemporal and angular parameters of the technique of clearing and running between hurdles by the world's strongest hurdlers specializing in the short hurdle sprint, and also to identify common factors.

Methodology and structure of the study. The research involved a statistical analysis and a processing of the spatiotemporal and angular characteristics of the technique employed by the finalists in the 2017 World Athletics Championship (London) who were running the 110 m hurdles (men) and 100 m hurdles (women). The initial data was obtained from IAAF Biomechanical Reports [2, 3].

Results and Discussion. Table 1 shows the spatiotemporal characteristics of clearing the hurdle (the 6th one for men and the 5th for women) and running

Table 1. *Spatiotemporal characteristics of the hurdle clearance phase and steps between hurdles for the 110m and 100m hurdles for the 2017 World Championship finalists*

Finalist	Hurdle clearance				First step			Second step		
	Contact-time (s)	Take-off (m)	Land-ing (m)	Flight time (s)	Contact-time (s)	Flight time (s)	Length (m)	Contact-time (s)	Flight time (s)	Length (m)
Men (110 m hurdles)										
O. McLeod	0,127	2,15	1,73	0,333	0,093	0,053	1,37	0,113	0,100	1,91
S.Shubenkov	0,127	2,10	1,73	0,320	0,087	0,053	1,42	0,120	0,100	2,04
B. Baji	0,113	2,21	1,79	0,347	0,100	0,033	1,36	0,120	0,100	1,89
G. Darien	0,140	2,28	1,39	0,313	0,087	0,053	1,47	0,127	0,093	2,01
A. Merrit	0,127	2,51	1,34	0,347	0,087	0,047	1,45	0,113	0,120	2,07
R. Brathwait	0,133	2,11	1,55	0,327	0,100	0,040	1,35	0,107	0,133	2,14
O. Ortega	0,120	2,24	1,63	0,353	0,087	0,040	1,35	0,120	0,120	2,06
H. Parchment	0,133	2,30	1,34	0,307	0,093	0,047	1,42	0,127	0,113	2,20
$\bar{x} \pm S_{\bar{x}}$	0,127± 0,003	2,23± 0,05	1,56± 0,06	0,331± 0,006	0,091± 0,002	0,046± 0,002	1,39± 0,02	0,118± 0,002	0,110± 0,005	2,04± 0,04
σ	0,008	0,13	0,06	0,017	0,005	0,007	0,05	0,007	0,14	0,11
Women (100 m hurdles)										
S. Person	0,107	2,11	1,15	0,300	0,087	0,067	1,70	0,113	0,113	1,67
H.Nelson	0,127	2,20	0,80	0,267	0,093	0,067	1,54	0,120	0,107	2,05
P. Dutkiewich	0,113	2,11	1,11	0,280	0,087	0,087	1,70	0,107	0,100	1,80
K. Harrison	0,120	2,08	1,06	0,280	0,100	0,073	1,57	0,113	0,107	1,90
C. Manning	0,127	2,10	1,02	0,273	0,087	0,067	1,57	0,120	0,100	2,01
A. Talay	0,113	2,23	1,10	0,313	0,087	0,060	1,63	0,113	0,113	1,71
N. Visser	0,127	1,95	1,08	0,260	0,093	0,093	1,72	0,113	0,107	1,95
N. Ali	0,133	2,05	1,15	0,267	0,113	0,060	1,54	0,120	0,100	2,02
$\bar{x} \pm S_{\bar{x}}$	0,121± 0,003	2,10± 0,03	1,06± 0,04	0,280± 0,006	0,093± 0,003	0,072± 0,004	1,62± 0,03	0,115± 0,001	0,105± 0,002	1,88± 0,05
σ	0,009	0,09	0,11	0,018	0,009	0,012	0,08	0,004	0,005	0,15
p	>0,05	<0,05	<0,001	<0,001	>0,05	<0,001	<0,001	>0,05	>0,05	<0,05

between hurdles by participants in the finals the 100 and 110 meters hurdles from the World Championship in 2017. The athletes are presented in order of final ranking.

The length of the hurdle step in men is significantly greater than in women ($p < 0.001$). Average values are 3.80m and 3.16m, respectively. Moreover, the greatest difference is observed in the landing distance. In men, it is half a meter more (1,56 ± 0,06 m and 1,06 ± 0,04 m, respectively, $p < 0,001$). The take-off distance is on average 15 cm longer. We can see the greatest range of values among men within the groups. The world record holder at this distance, A. Merrit, has the smallest landing distance of 1,34 m, but the longest take-off distance of 2,52cm. In women, H. Nelson, a silver medalist, has the smallest landing distance , and she has one of the longest take-off distance – 2,20 m.

The contact time during the take-off phase in women is also slightly better than in men, at an average of 0,12 s. Sally Pearson, Olympic and World Champion, has the best figure of 0,107 s. This value is similar to those of the contact time of the strongest sprinters.

The total time taken to clear the hurdle for women is significantly better than for men, on average by 0,05 s. The average value for women is 0,280± 0,006 s, for men 0,331±0,006 s ($p<0,001$). The best result among men is 0,307 s by the Jamaican, 8th placed H. Parchment. One of the best hurdlers in the world of recent years, 2015 World champion and the silver medalist in this final, the Russian, Sergey Shubenkov, clears the hurdle in 0.320 s, which is the third-best result. It is worth noting that in women, the winner of this championship, S. Pearson, has one of the worst result – at 0,30s. The best values belong to the 7th and 8th places respectively, to N. Visser and N. Ali with 0,26 s.

The following pattern can be distinguished in running between hurdles. The average value of the contact time at the landing phase has approximately the same value for men and women at 0,09 s. At the same time, the flight time of the first step in men is much less – 0,046 ± 0,002 s; in women 0,072 ± 0,004 s, ($p < 0,001$). This data is consistent with the shorter first step length in men (mean value of 1,39 m). In women it is 1,62 m. The contact of the second step for almost all the athletes under consideration is 0,11-0,12 s. The average value of the flight time is somewhat faster for women (0,11-0,12 s), but for men there is a wider range of values (from 0,09 to 0,12 s). The length of the second step in men, compared to the first, is longer by an average of 15 cm. But strong differences are also observed within the groups. In men, one of the tallest

Table 2. *Angular kinematics at the hurdle clearance phase of 110m hurdles and 100m hurdles for the 2017 World Championship finalists*

Finalist	Take-off phase					Landing phase			
	Lead leg knee angle	Trail leg knee angle	Deviation angle	Trunk angle	Trunk-thigh angle	Lead leg knee angle	Trail leg knee angle	Trunk angle	
								Touch-down	Toe-off
Men (110 m hurdles)									
O. Mc Leod	77,2	153,9	64,0	75,7	70,5	177,6	79,4	65,4	86,4
S.Shubenkov	74,7	159,0	64,4	64,1	53,9	175,4	80,2	62,6	78,9
B. Baji	76,0	167,7	65,0	71,8	68,9	169,3	76,4	65,9	79,3
G. Darien	77,1	158,9	60,8	72,4	65,1	165,2	81,8	60,3	73,5
A. Merrit	73,9	155,7	65,6	63,8	57,1	173,3	82,5	54,7	68,2
R. Brathwait	69,8	159,1	65,6	76,2	82,8	150,0	82,9	65,0	79,9
O. Ortega	70,9	163,7	66,0	76,6	80,4	161,4	81,3	61,0	82,5
H. Parchment	75,7	166,1	63,4	82,2	66,1	157,5	79,7	49,7	70,9
$\bar{x} \pm S_{\bar{x}}$	74,4± 1,0	160,5± 1,7	64,4± 0,6	72,9± 2,2	68,1± 3,5	166,2± 3,4	80,5± 0,7	60,6± 2,0	77,4± 2,2
σ	2,7	4,9	1,7	6,3	10,0	9,5	2,1	5,7	6,1
Women (100 m hurdles)									
S. Person	67,7	162,4	66,9	74,9	88,7	173,6	80,6	59,5	78,4
H.Nelson	53,2	156,6	63,1	71,0	74,8	150,6	83,7	48,7	63,5
Dutkiewich	63,9	155,5	63,1	67,6	67,7	153,4	77,4	64,2	76,5
Harrison	90,5	167,8	62,9	71,4	84,0	151,5	78,3	67,9	79,8
Manning	69,7	159,0	59,9	70,8	76,5	154,9	82,9	54,4	70,8
Talay	60,5	141,6	64,2	72,8	80,9	146,7	82,2	57,2	77,6
Visser	65,6	153,9	63,4	71,1	74,0	162,9	78,5	62,5	75,1
N. Ali	79,1	173,8	59,1	73,7	80,7	152,5	74,5	58,3	78,9
$\bar{x} \pm S_{\bar{x}}$	68,7± 4,1	158,8± 3,4	62,8± 0,9	71,6± 0,8	78,4± 2,3	155,7± 3,0	79,8± 1,1	59,1± 2,1	75,1± 1,9
σ	11,5	9,7	2,4	2,4	6,5	8,6	3,1	6,0	5,4
p	>0,05	>0,05	>0,05	>0,05	<0,05	<0,05	>0,05	>0,05	>0,05

participants R. Baji has the shortest second step of 1,89m and the largest one belongs to H. Parchment at 2,20 m. On average, the increase in the second step compared to the first is 36-55%.Curiously, women demonstrate both a decrease in the second step compared to the first (S. Pearson by 3 cm), and an increase of 8-10 cm in A. Talay and P. Dutkiewich –whilst the rest show an increase of 20-50 cm.

Table 2 shows the angular characteristics of the hurdle clearance. The value of the deviation angle in men is practically the same as in women - (64,4±0,6° and 62,8±0.9°, respectively, p>0,05). Moreover, in men, it has a direct correlation with the contact time at take-off phase (k=0,73, p<0,05). This means runners with sharper deviation angle clear it faster. In women, the deviation angle has a negative correlation with the contact time (k= - 0,82, p<0,05). In this case, the indicators of the Olympic champion and the winner of this World Championship, S. Pearson, could be noteworthy. She demonstrates the fastest contact time (including men) – 0,107 s and at the same time the greatest deviation angle – 66,9°.

The trunk angle does not show significant differences – 72,9 ± 2,2° in men and 71,6±0,8° in women (p > 0,05). However, the range of values among male-hurdlers is significantly greater than among female-hurdlers – from the 64° of S. Shubenkov and A. Merrit to the 82° of H. Parchment. The lead leg knee angle at toe-off does not show any significant differences (p > 0,05). But if for men this indicator is relatively stable and is in the range of 70-77°, then for women there are some significant differences (53-90°). An analogous situation is in the trail leg knee angle. Among men, the trail leg during the take-off phase is flexed most strongly by O. McLeod (153°), who is the shortest among the participants in the final at 180 cm. The tallest flex the trail leg least of all, like B. Baji (167,7°) and H. Parchment (166.1°). Women demonstrate a

significant range of values, from 141° for A. Talay to 173° for N. Ali. Significant differences between men and women are observed in the trunk-thigh angel at take-off phase (68,1±3,5° and 78,4±2,3°, respectively, p <0,05).

In the landing phase at touch down, significant differences were observed only in the lead leg knee angle: 166,2±3,4° in men and 155,7±3,0° in women (p<0,05). O. McLeod, S. Shubenkov and A. Merrit bend their leg least of all (about 175°, i.e. the leg is placed almost straight on the ground). For women, about the same value is observed for the winner, S. Person. For the rest of the participants, the leg bends significantly more (146°-154°).

There are relatively equal values for men and women in the deviation angle at landing phase (the angle between a straight line drawn from the center of mass to the spot where the foot is placed on the support and the horizontal): 74-83°. The average value of the trunk angle at touchdown in both groups is about 60°. Here, the minimum and maximum values are approximately equal, about 49° and 67°, respectively. During the first step, at the moment of removing the leg from the support, this angle increases on average to 77° for men, and up to 75° for women.

Conclusion. The main significant differences between men and women in a short hurdle sprint are observed in the take-off and landing distances, hurdle flight time and distance, in the flight time of the first step, the length of the second step and the change in the length of the second step in relation to the first. Among the angular parameters, there are significant differences in the trunk-thigh angle at toe-off, and the lead leg knee angle at touchdown. The presented findings can be used in the development and use of technical training means for top level athletes.

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Safety of physical education lessons according to teachers

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Abstract

Safety of physical education (PE) lessons poses a serious challenge to the functioning of the contemporary educational system. Research shows that there are numerous causes of accidents that result in injuries. This study sought to analyse PE teachers' opinions regarding safety during lessons and potential risks associated with it. The analysis included 79 PE teachers employed in 17 schools. The author's own questionnaire was used as the research tool. Prior to the research, the questionnaire was checked in terms of reliability. Over 67% of the respondents stated that students' low physical fitness level was the main cause of accidents during PE lessons, while 58% of the study participants pointed to poor condition of sports facilities. It leads to a variety of injuries such as bruises, head and face injuries or sprains.

Keywords: injuries, school accidents, student, physical fitness level.

Background. Physical education (PE) plays an immensely important educational and health-promoting role. It is an indispensable part of the health education system that is gaining significance due to numerous lifestyle diseases that already affect young generations. PE lessons are distinctive because of a higher risk of dangerous situations which may lead to injuries or even death. Statistical data show that accidents during PE lessons account for over 50% of all the accidents that take place in schools, and their number reaches tens of thousands. Therefore, safety of students during PE lessons constitutes schools' primary responsibility, and it mainly falls on PE teachers.

This study sought to analyse PE teachers' opinions regarding safety during lessons and potential risks associated with it.

Research methods and organisation. Seventy-nine PE teachers from 9 primary and 8 secondary schools from Lublin region participated in this anonymous study. The author's own questionnaire was used as the research tool. Personal data collected in the course of the study included the length of professional experience and the type of school the teacher was employed in. The respondents were divided into 4 groups depending on the length of their professional experience. The division corresponded to the duration of particular stages of the professional promotion process. The questions included in the questionnaire concerned aspects of safety during PE lessons, causes of accidents and dangerous situations as well as professional skills of teachers.

Results and discussion. The reliability score for all the analysed variables (expressed with Kappa coefficient) was equal to or higher than 0.93. The questionnaire was completed twice with an interval of one month. No significant differences between the results obtained in the two tests were revealed ($p<0.05$).

Out of 79 respondents, 53 teachers (67.1%) claimed that low physical fitness level was the main cause of accidents during PE lessons. This view was expressed by teachers with the longest and the shortest professional experience. Poor condition of sports

facilities was the second most common cause indicated by the study participants (58.2%). Too many students attending PE lessons was another frequent reason they reported (40.5%). It can be noted that together with an increase in the length of professional experience, there occurs a decrease in the number of teachers claiming that the lack of discipline on the part of students is the main cause of accidents (62.5 % vs. 50.0% vs. 45.0% vs. 39.1%) (Tab. 1).

Afterwards, teachers were asked about the most common injuries picked up during PE lessons. In their opinion, students most frequently experienced lower limb bruises (41.8%), head and face injuries (34.2%) as well as upper limb bruises (30.4%). Other injuries that teachers mentioned were skin abrasions and wounds (26.6%). Lower and upper limb fractures were indicated as the least common injuries (Tab. 1).

Almost 47% of the respondents stated that in terms of safety, sports facilities available at school were satisfactory, while over 39% of the teachers considered them to be good. Only one in ten study participants claimed the facilities were very good, while very few of them (1.3%) were convinced they were in poor condition. Similar responses were provided by teachers with the shortest and the longest professional experience (Tab. 2).

Moreover, teachers were asked to self-assess their knowledge of legal regulations concerning safety. The

Table 1. *The most common causes of accidents and injuries during PE lessons according to teachers, with regard to the length of their professional experience (n=79)*

	Experience								Total	
	< 3 years		4 to 6 years		7 to 10 years		> 10 years			
	n (16)	%	n (20)	%	n (20)	%	n (23)	%	n (79)	%
Causes of accidents during PE lessons*										
faulty equipment	5	31.3	7	35.0	7	35.0	8	34.8	27	34.2
poor condition of sports facilities	10	62.5	11	55.0	9	45.0	16	69.6	46	58.2
lessons conducted in school corridor	4	25.0	3	15.0	5	25.0	2	8.7	14	17.7
large number of students	8	50.0	7	35.0	8	40.0	9	39.1	32	40.5
large number of groups in one place	7	43.8	4	20.0	5	25.0	4	17.4	20	25.3
no discipline on the part of students	10	62.5	10	50.0	9	45.0	9	39.1	38	48.1
low physical fitness level of students	12	75.0	14	70.0	13	65.0	14	60.9	53	67.1
teacher's organisational errors	2	12.5	4	20.0	6	30.0	5	21.7	17	21.5
students left without supervision	2	12.5	3	15.0	3	15.0	4	17.4	12	15.2
overestimation of one's skills	4	25.0	2	10.0	3	15.0	6	26.1	15	19.0
participation of students who report feeling unwell	3	18.8	5	25.0	3	15.0	2	8.7	13	16.5
lack of knowledge about students' health status others	3	18.8	1	5.0	0	0.0	2	8.7	6	7.6
	0	0.0	0	0.0	1	0.5	0	0.0	1	1.3
Most common injuries picked up during PE lessons*										
lower limb bruises	8	50.0	7	35.0	9	45.0	9	39.1	33	41.8
upper limb bruises	4	25.0	5	25.0	6	30.0	9	39.1	24	30.4
lower limb fractures	1	6.3	2	10.0	2	10.0	3	13.0	8	10.1
upper limb fractures	1	6.3	1	5.0	4	20.0	4	17.4	10	12.7
knee sprains	3	18.8	2	10.0	3	15.0	4	17.4	12	15.2
wrist sprains	3	18.8	4	20.0	3	15.0	5	21.7	15	19.0
ankle sprains	5	31.3	6	30.0	5	25.0	6	26.1	22	27.8
head and face injuries	7	43.8	5	25.0	6	30.0	9	39.1	27	34.2
others	6	37.5	4	20.0	6	30.0	5	21.7	21	26.6

** it does not add up to 100% because more than one response could be provided*

Table 2. *Assessment of sports facilities, knowledge of safety rules and fears of teachers, with regard to the length of their professional experience*

	Experience								Total	
	< 3 years		4 to 6 years		7 to 10 years		> 10 years			
	n (16)	%	n (20)	%	n (20)	%	n (23)	%	n (79)	%
Condition of sports facilities in terms of safety										
very good	1	6.3	2	10.0	2	10.0	3	13.0	8	10.1
good	4	25.0	7	35.0	9	45.0	11	47.8	31	39.2
satisfactory	10	62.5	10	50.0	9	45.0	8	34.8	37	46.8
poor	0	0.0	0	0.0	0	0.0	1	4.3	1	1.3
no opinion	1	6.3	1	5.0	0	0.0	0	0.0	2	2.5
PE teachers' knowledge of safety rules										
very good	4	25.0	8	40.0	8	40.0	11	47.8	31	39.2
good	4	25.0	6	30.0	8	40.0	7	30.4	25	31.6
satisfactory	3	18.8	4	20.0	2	10.0	2	8.7	11	13.9
poor	2	12.5	1	5.0	0	0.0	0	0.0	3	3.8
no opinion	3	18.8	1	5.0	2	10.0	3	13.0	9	11.4
Sources of knowledge of safety rules*										
university studies	13	81.3	10	50.0	7	35.0	8	34.8	38	48.1
professional experience	1	6.3	5	25.0	10	50.0	13	56.5	29	36.7
Internet	6	37.5	3	15.0	3	15.0	0	0.0	12	15.2
courses/training	0	0.0	8	40.0	5	25.0	8	34.8	21	26.6
professional literature	2	12.5	1	5.0	0	0.0	1	4.3	4	5.1
Fear of accidents during PE lessons										
I am not afraid	6	37.5	6	30.0	4	20.0	2	8.7	18	22.8
accident due to my negligence	1	6.3	0	0.0	2	10.0	2	8.7	5	6.3
accident due to student's negligence	5	31.3	8	40.0	6	30.0	9	39.1	28	35.4
random event	4	25.0	6	30.0	8	40.0	10	43.5	28	35.4

** it does not add up to 100% because more than one response could be provided*

largest group consisted of teachers who believed their knowledge was very good (39.2%) and good (31.6%). Only a few respondents stated their knowledge in this field was poor (3.8%) (Tab.2).

More than 81% of the teachers with professional experience of less than 3 years and 50% of the teachers with experience of 4 to 6 years indicated that university studies were their main source of knowledge of safety regulations. In the group of respondents with 7 to 10 years of teaching experience as well as in those who had been working in this area for more than 10 years, the sources of knowledge included professional experience (50.0% vs. 56.5%, respectively), followed by courses and training completed during their professional careers (25.0% vs. 34.8%, respectively) (Tab. 2).

Teachers were most often afraid that accidents during PE lessons would be caused by students themselves or would occur as a result of a random event (35.4%). It can be noted that with an increase in the length of professional experience, the percentage of teachers who claimed they felt no concern about potential injuries and accidents decreased (37.5% vs. 30.0% vs. 20.0% vs. 8.7%) (Tab. 2).

Summary and conclusions

1. The findings of the present study revealed numerous causes of accidents during PE lessons. They are associated with students' low levels of physical fitness, the lack of discipline, poor condition of sports facilities as well as faulty sports equipment at school. Only one in ten study participants considered their sports facilities to be very good. Another problem is constituted by large numbers of students in groups. Every fifth respondent also stated that the causes include teachers' organisational errors.

2. Accidents that occur during PE lessons cause a lot of injuries, both serious ones, such as fractures or sprains, and minor ones, e.g. bruises or abrasions.

3. PE teachers consider their knowledge of safety rules to be very good. Only one in four respondents acquired this knowledge through participating in professional courses and training.

4. More than 75% of the study participants were afraid that accidents might take place during their lessons. It concerned both random events and students' negligence.

Practical applications

The results of the study show that educational bodies should pay close attention to the issue of safety during PE classes. The specificity of the subject indicates that it is inextricably linked to a variety of dangerous situations that cannot be eliminated entirely; however, every effort ought to be made to reduce these risks. It often requires considerable investments in sports facilities and equipment. Too large groups and working in crowded places significantly increase the risk of accidents and other perilous situations. PE teachers point to the need for changes, as they are afraid accidents will take place during their lessons. Therefore, educational institutions should offer regular courses that would equip teachers with necessary knowledge regarding legal responsibility. Without the above-mentioned changes, PE lessons will still rank highest when it comes to accidents.

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Institutional transformation of master's degree in physical education and sports

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Abstract

Objective of the study was to identify trends in the development of the Master's degree program within the structure of vocational education in the physical education and sport sector.

Results and conclusions. The authors note that the change in the role of the Master's degree in the educational process structure is due to the labor market which ensures an increasing social demand for specialist training in the physical culture and sports sector.

There is a positive trend towards an increase in the demand for masters in physical education and sports in mature age, which is driven by the conscious desire of students to acquire a new profession, have the choice and opportunity to realize their potential. This testifies to the social and academic mobility of the population.

The fast growing academic mobility urges the academic community to give a special priority to the background (ideally fundamental) education as a basis for a grounded choice of a master course to meet an actual demand for the physical education and sport specialist training service in the current socio-economic situation. It should be emphasized that the social demand for professional physical education and sport specialists remains high and steady. New market trends need to be responded by the specialists' academic and professional mobility facilitation initiatives. A special priority to the formal physical education and sport specialist background and/or physical education and sport specialist retraining certificate will be given when the graduate opts for a professional coaching career (49.04.03 Sports discipline) that requires, among other sensitive things, special competences in the trainees' health safety domain.

Keywords: *magistracy, multilevel education system, academic mobility, occupational mobility, vocational education, physical education and sports, specialist training.*

Background. The topic analyzed herein is in a growing priority due to the academic physical education and sport specialist training service development challenges in the context of the ongoing reforms of the national education system on the whole. The study makes a special emphasis on the magistracy progress trends in the physical education and sport specialist training system.

It was in the 1990s that magistracy was reinstated in the national multilevel academic educational system closely mimicking the classical university model – that historically combines theoretical and practical education with a research project activity [1, 2]. Bachelor in this model will continue studies in the relevant magistracy as required by his/her background education, with the studies crowned by a PhD dissertation and exams. One of the fundamental provisions of this model is that magistracy trains teachers for the higher education system, with the students expected to developed interests in and competences and skills for the relevant research projects viewed as an essential component of their academic service at universities.

A few recent decisions made by the relevant governmental agencies have changed the mission and role of magistracy in the research/ teaching specialist training system, including the physical education and sport specialist training one. In addition to its

bachelor and research specialist training responsibilities, magistracy now provides a professional retraining service, with the trainees, upon two years of studies, certified for the professional service that may totally differ from their bachelor background.

Objective of the study was to analyze the modern magistracy progress trends in the academic physical education and sport specialist training service system.

Results and discussion. Reforms of magistracy in the national educational system are largely dictated by the labor market development trends with the growing social demand for the professional physical education and sport specialists. The efforts to meet the social demand for the physical education and sport specialists of different formal qualifications have to take into account a variety of special issues and regulatory mechanisms for the labor markets, educational services and employment system on the whole with the employment and progress opportunities for the physical education and sport specialists on the modern Russian markets. It should be emphasized that the reforms are intended to establish a new system to efficiently balance the supply and demand in the labor markets and in the educational service system [3]. Given in Table 1 herein are the background educations of the master course entrants reported by the Lesgaft National State University.

Table 1. *Background educations of the master course entrants (n=1319) in Lesgaft National State University in 2016-2019: 49.04.01 Physical Education and 49.04.03 Sports disciplines*

Year	Entrants	Physical education and sports background, %	Other backgrounds, %
2019	343	191/55,7	152/ 44,3
2018	346	229/ 66,2	117/ 33,8
2017	342	193/ 56,4	149/ 43,6
2016	288	177/61	111/38,5

Note that the above entrants' inflow data are indicative of the growing demand for the academic physical education and sport specialist training service. Given in Table 2 hereunder is the age grouping of the entrants to the master course for 2016-19: they were 20 to 57 years old.

The high demand for the physical education and sport professionals, determinations of the students interested in new specialty for their professional progress agendas in the age of discretion, when the individual resource is fully realized - all these and other factors are undoubtedly positive as they contribute to the social and academic mobility, life quality and social health improvement agenda. To put it in other words, the new progress trends in the physical education and sport specialist training master course may be viewed as highly beneficial in many humanitarian contexts including the opportunities for the national sport elite to have a vocational training service upon retirement from active sports.

Table 2. *Age groups and numbers of the master course entrants in Lesgaft National State University in 2016-2019: 49.04.01 Physical Education and 49.04.03 Sports disciplines*

Age	2016	2017	2018	2019
20-25	228/79,1	258/74,8	258/74,6	251/73,2
26-30	27/9,4	49/14,6	46/13,3	42/12,2
31-35	22/7,6	21/6,8	13/3,8	19/5,5
36-40	0/0	3/0,9	10/2,8	16/4,7
41-plus	11/3,8	11/3,6	19/5,5	15/4,4
Total	288	342	346	343
Seniors	52 years old	57 years old	56 years old	55 years old

One more positive trend is that the magistracy, if it fully retains its researcher/ teacher training capacity, will secure a growing inflow of the trained human resource to the sector with the specialists having widely varied backgrounds. The integrative and interdisciplinary physical education and sport theoretical and practically backgrounds are known to facilitate modern research in the physical education and sport service sector. It may be pertinent to mention in this context that presently a special priority is given to many issues of the elite sport axiology in the context of modern health culture and issues of medical service in sports, and the relevant research needs to be supported by the theoretical studies in anthropology, philosophy, law and many other interdisciplinary research fields.

It is clear that the above research challenges need to be addressed by the highly professional specialists having different backgrounds – in medicine, law, mathematics, philosophy, sociology etc. – and particularly those having practical physical education and sport experiences and motivations for the professional physical education and sport specialist service. Generally the design concept of the national academic physical education and sport specialist training system with its university structure and departments give the means to fulfill the mission. The existing magistracy could be upgraded to offer the specialist training service for research in the priority theoretical and practical subjects of the national physical education and sport system. Such specialist training service giving the competencies

for progress in the modern sport science and physical education and sport theory and practice implies that the academic community should reconsider the logics and contents of the existing vocational education system.

The key problem that needs to be solved in this context is the background and master education harmonizing one. As things now stand, a bachelor of economics may qualify for a master's degree program in teacher education; a bachelor of law may master in sociology; a bachelor of engineering may opt for an economics master course etc. It should be noted that the master's degrees are the same for the specialists having different backgrounds – and this situation cannot but cast doubts on the specialist training quality and actual values of the diplomas.

When an entrant to the Physical Education / Sports magistracy has a different background, it could be beneficial to offer the training module taking full benefits of the actual prior background/ formal profile. Presently the law allows an individual mastering in any field other than his/her background education. In this situation, academic 49.04.01 Physical Education and 49.04.03 Sports disciplines need to offer special education curricula/ modules to bridge the gaps in the biomedical and/or theoretical background education to successfully train the students for multiple interdisciplinary subjects in the modern physical education and sport theory and practice.

Conclusion. The fast growing academic mobility urges the academic community to give a special priority to the background (ideally fundamental) education as a basis for a grounded choice of a master course to meet an actual demand for the physical education and sport specialist training service in the current socio-economic situation. It should be emphasized that the social demand for professional physical education and sport specialists remains high and steady. New market trends need to be responded by the specialists' academic and professional mobility facilitation initiatives. A special priority to the formal physical education and sport specialist background and/or physical education and sport specialist retraining certificate will be given when the graduate opts for a professional coaching career (49.04.03 Sports discipline) that requires, among other sensitive things, special competences in the trainees' health safety domain.

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Professional teaching service values and agenda: formation progress test model for physical education department

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Abstract

Objective of the study was to offer a professional teaching service values and agenda formation progress test model and test it at Physical Education Department.

Methods and structure of the study. The two-stage study was run at the Evseviev Mordovian State Pedagogical Institute. We sampled for the new model testing experiment the 3-year (n=32) and 4-year (n=21) students mastering in 03.44.05 Pedagogical Education discipline with its PE and Life Safety specialties. The professional teaching service values and agenda formation progress in the sample was rated by the following adapted tests: M. Rokeach Priority Values test; and the Professional Service Agenda test with its key component testing procedures.

Results and discussion. The study data and analyses made it possible to profile the professional teaching service values and agenda formation progress in the Physical Education Department students as a part of the academic progress on the whole. The individual professional teaching service values and agenda effectively shape up the world outlooks, service responsibility and determination for success, with due appreciation of and motivations for university studies and future teaching service. Deficiencies in the professional teaching service values and agenda formation domain may stall progress in the individual cognitive resource and personal responsibility development domains and give rise to indifference and formalism in the education process.

Keywords: *professional teaching service values and agenda, student, Physical Education Department, progress tests, values.*

Background. Modern theoretical pedagogical psychology gives a special priority to the professional teaching service values and agenda formation issues including the training process goals, content, design and management issues etc. As things now stand, the national research community still needs to give more practical attention to the specific professional teaching service values and agenda formation issues since the available knowledgebase is rather extensive albeit too general.

Objective of the study was to offer a professional teaching service values and agenda formation progress test model and test it at Physical Education Department.

Methods and structure of the study. The two-stage study was run at Mordovian State Pedagogical Institute named after M. E. Evseviev. We sampled for the new model testing experiment the 3rd-year (n=32) and 4th-year (n=21) students mastering in 03.44.05 Pedagogical Education discipline with its Physical Education and Life Safety specialties. The professional teaching service values and agenda formation progress in the sample was rated by the following adapted tests: M. Rokeach Priority Values test; and the Professional Service Agenda test with its key component testing procedures.

Results and discussion. The first stage of the study was designed to analyze the relevant theoreti-

cal and practical literature. We found that agenda may be defined as the fundamental personality substructure critical for the individual progress in socialization and professional service domains with its self-control and management, situation assessment, responses, decision-making, individual resource mobilizing and progress self-rating aspects [3, p. 180]. Professional teaching service values and agenda in this context may be interpreted as the teacher's awareness of and positioning the pedagogical service, pedagogical communication and personality priority domains.

Having analyzed the valid educational service regulatory provisions for the purposes of the study, we found the following key standard competences versus the academic disciplines for the professional teaching service values and agenda formation in the Physical Education Department students. Basic cultural competences including basic cultural competence-2: competence to analyzing the main historical progress stages and logics for the civic positioning (general history, physical education and sports history and sociology); basic cultural competence-6: self-reliant learning and self-management competences, for progress in the physical education and sport specialist service; basic cultural competence-8: individual physical fitness competence for success in the physical education and sport service, health sports, active games etc. Basic professional competences: basic professional competence-1: competence in the social role of and motivations for the teaching service (pedagogy, physical education and sports progress related teaching service); basic professional competence-3: competence in the teaching service psychology and pedagogy (psychology, physical education-and-sport-specific psychology). And professional competences: professional competence-3: problem solving competence for teaching, spiritual and moral progress facilitation service on a class/ off-class basis (transport safety, sociopathy prevention service etc.); professional competence-4: competence in the personality, meta-subjective and subjective progress encouragement teaching service with a special emphasis on the educational service quality in every subject (with modern learning progress tests, physical education

Table 1. *Rokeach Priority Values test data*

Goal values	3-year group		Value group	4-year group		Value group
	%	Rank		%	Rank	
Professional values:						
1 Active life	18,8	1	2	14,3	4	3
4 Interesting job	18,8	6		14,3	15	
11 Learning	21,9	15		9,5	5,13,14,15	
10 Public appreciation	15,6	7, 14		9,5	12	
7 Wealth	18,8	4		23,8	3	
Personality values:						
2 Wisdom	12,5	2,9	1	14,3	9, 12	1
3 Health	53,1	1		57,1	1	
6 Love	12,5	2, 3, 5, 7		14,3	10	
8 Good friends	18,8	5		14,3	3, 4, 14	
15 Happy family	15,6	3		23,8	7	
18 Fun	12,5	7,12,13,18		14,3	17	
Specific values:						
14 Freedom and independence	15,6	18	3	14,3	10, 12	2
9 Good social climate	18,8	8		23,8	11	
13 Independence as freedom of speech	18,8	13		14,3	4	
12 Equality	21,9	12		9,5	8, 13,16	
17 Self-confidence	12,5	6, 9, 11, 15		14,3	11	
Abstract values:						
5 Natural beauty, arts	15,6	13, 17, 18	4	19,1	18	4
16 Creativity	18,8	16		14,3	17, 18	

theory and practice etc.). Note that these competences represent only a small share of the total competences related to the professional physical education and sports teaching service values and priorities [2, p. 9].

The second stage of the study was geared to analyze the basic values and rate the professional teaching service values and agenda formation progress in the Physical Education Department sample using the Rokeach Priority Values test and the Professional Service Agenda componential test [1, p. 22].

Based on the M. Rokeach test data, we found the priority values of the sample of special influence on the professional teaching service values and agenda formation progress – that were academic-year-specific to a degree. Thus the 3-year group terminal values (goal values) were found to prioritize personal life value ranked number 1; and professional success ranked number 2, followed by a few specific and abstract values; whilst the 4-year group ranked the personal life value number 1 followed by some specific values, and then the professional success value and abstract values. It should be noted that the values grouping by students was vague in many aspects, with many values apparently underrated by the sample.

The professional teaching service values and agenda formation progress tests were geared to rate every teaching service aspect including: teaching service motivations, responsibility, objective self-rating, creativity etc. The teaching service was interpreted as the self-rating in the professional motivations and teaching service capacity domains using the following three professional teaching service values and agenda formation criteria: (1) core orientations; (2) behavioral drivers; and (3) professional success motivations. We run a questionnaire survey to rate the professional teaching service values and agenda in the sample: see Table 2.

The questionnaire survey data and analysis showed a year-to-year progress in the sample. Thus 25.0% and 28.6% of the 3- and 4-year groups (re-

Table 2. *Professional teaching service values and agenda components rated by a questionnaire survey, %*

	Criteria	3 year	4 year
Core orientations	*Personal resource*		
	A. Situation-specific responses	21,8	23,8
	B. Self-assertion in service	25,0	28,6
	C. Intellectual progress	15,6	28,6
	D. Self-control in learning	12,5	9,5
	Personality motivations for teaching service		
	A. Interest in the teaching service	15,6	28,6
	B. University/ department image/ rank	15,6	28,6
	C. Social value of the profession	21,8	14,3
	D. Best potential in this field	31,3	23,8
Behavioral drivers	*Vocational self-assertion*		
	A. Vocational self-fulfillment	56,3	28,6
	B. Pleasure from learning and teaching service	25,0	19,1
	C. Self-exploration in communication with students	15,6	14,3
	D. Self-analysis	12,5	4,7
	E. Personal experience and capacity mobilizing in the teaching service	46,8	42,8
	Professional values: self-rates		
	A. Poor knowledge quality controls	0	4,7
	B. Teamwork culture and behavior	25,0	28,6
	C. Relations in the academic community	15,6	23,8
Professional success	*Self-rates*		
	A. Personal experience and capacity mobilizing for learning	34,4	42,8
	B. Satisfaction with the own progress	34,4	23,8
	C. Responsibility in studies	65,6	23,8
	D. Own drawbacks analyzing capacity	31,3	25,0

spectively) were found capable to self-assert them in studies and teaching service; 15.6% and 28.6% of the 3- and 4-year groups (respectively) were tested with intellectual progress; 15.6% and 28.6% of the 3- and 4-year groups (respectively) reported growths of interest in their profession; and 15.6% and 28.6% of the 3- and 4-year groups (respectively) were tested with the growing appreciation of the university image/ rank.

The professional teaching service values and agenda formation implies not only the vocational self-identification but also progress in motivations for and priorities in the learning, teaching service, growth of the teaching-service-related knowledgebase and competences and visioning of own professional progress [4]. We believe that a special priority will be given to the students' values building in the academic education process to facilitate learning progress and motivations and help the students attain the individual goals in every academic discipline.

Conclusion. The study data and analyses made it possible to profile the professional teaching service values and agenda formation progress in the Physical Education Department students as a part of the academic progress on the whole. The individual professional teaching service values and agenda effectively shape up the world outlooks, service responsibility and determination for success, with due appreciation of and motivations for university studies and future teaching service. Deficiencies in the professional teaching service values and agenda formation domain may stall progress in the individual cognitive resource and personal responsibility development domains and give rise to indifference and formalism in the education process.

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Extracurricular health sports service design and management: practical training model for future physical education teachers

UDC 378.1

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Abstract

Objective of the study was to develop a practical training model to equip the future physical education teacher with extracurricular health sports service design and management skills.

Methods and structure of the study. We used for the purposes of the study theoretical analysis of the psychological and pedagogical literature on the subject, abstracts, systemic analysis, synthesis and design methods.

Results and discussion. The model of the process under study was designed based on the identification of its structural units: task-oriented, theoretical and methodological, content-related, procedural, evaluation. The task-oriented section of the model is presented as the main objective – to build extracurricular sports and fitness activities organizing skills in future physical education teachers. The theoretical and methodological basis of the designed model is formed by the theoretical foundations of continuing pedagogical education, academic professional teacher training, theoretical foundations of the vocational education system in the physical education and sport sector, conceptual ideas of practice-oriented approaches in the context of higher vocational education. The content-related unit of the model is represented by the body of knowledge and skills necessary for future physical education teachers to successfully organize extracurricular sports and fitness activities. The procedural unit of the model is represented by the instructor-led form of organization of classes for future physical education teachers and their independent work during the study in the Pedagogics and Physical education theory and methodology disciplines, as well as when performing the practical tasks to build professional skills and experience. The evaluation section of the model shows the efficiency of the physical education teacher training for extracurricular sports and fitness practices.

Keywords: *practical training model, extracurricular health sports service, physical education teacher, case study, business game, professional skill test.*

Background. As provided by the valid Federal State Secondary General Education Standards (FSSGES), extracurricular service means the "education service other than the traditional class learning system designed and managed so as to attain the educational service goals of the basic secondary education curricula" [3]. Modern school extracurricular health sports service offers a range of special extra progress opportunities for students to satisfy their natural communication, self-assertion and self-improvement needs [1, 5]. This is the reason why the national educational community gives a special priority to the future physical education teacher training models making an emphasis on the extracurricular health sports service design and management skills. It should be mentioned, however [4], that “basic higher pedagogical education curricula are designed to equip the students mostly with practical competences in the traditional class education service”; and, hence, the national pedagogical universities have to update the educational curricula to equip the future physical education teacher with fair extracurricular health sports service design and management skills using a wide variety of models and tools, with a special emphasis on the practical training ones.

Objective of the study was to develop a practical training model to equip the future physical education teacher with extracurricular health sports service design and management skills.

Methods and structure of the study. We used for the purposes of the study theoretical analysis of the psychological and pedagogical literature on the subject, abstracts, systemic analysis, synthesis and design methods.

Results and discussion. It is traditional for the modern pedagogical science to model a subject process by categorizing it into a few modules including basically the goal-setting, theoretical and practical provisioning, substantive, procedural and progress testing ones. Let's analyze them in more detail for the new practical training model to equip the future physical education teacher with the extracurricular health sports service design and management skills.

Goal-setting module sets the key goal that is to train the future physical education teacher for extracurricular health sports service, with the goal further detailed by the following tasks: (1) Facilitate development of special interest in, motivations and practical needs for extracurricular health sports service; (2) Build up a theoretical knowledgebase for extracurricular health sports service; and (3) Develop the extracurricular health sports service skills and practical experience in the future physical education teacher for success in the future professional service.

Theoretical and practical provisioning module was designed based on the theoretical basics for the lifelong pedagogical education laid by E.I. Artamonova, V.A. Bolotov, S.A. Pisareva, A.P. Tryapitsina et al.; professional teacher training models for universities offered by E.V. Balakireva, E.M. Ibragimova, I.A. Kolesnikova et al.; theoretical grounds for a physical education and sports service specialist developed by V.K. Balsevich, L.I. Lubysheva, A.P. Matveyev et al.; and the concepts and ideas for practical academic training service by N.V. Meseneva, E.H. Mychko et al.

Substantive module offers the extracurricular health sports service knowledge and skill sets for the future physical education teacher including: competency in the extracurricular health sports service regulatory provisions; special extracurricular health sports service models and tools and their differences from the traditional class service; extracurricular health sports service design formats; extracurricular health sports service modules; interactive extracurricular health sports service forms and the applicable innovative technologies; progress planning and testing methods and tools applicable on an individual, subject-specific and meta-subjective bases. The substantive module also spells out the extracurricular health sports service design and management skills, e.g.: design the relevant health sports projects using the best applicable technologies; develop the extracurricular health sports service programs compliant with the valid Federal State Education Standards; select and classify the learning materials for the extracurricular health sports service and health sports projects; model the health sports projects sessions; and make health sports projects progress analyses and self-analyses. The substantive module gives a special priority to the most efficient practical training methods and tools.

Procedural module sets a frame for the class studies and self-reliant learning in Pedagogy and Physical Education Theory and Practice disciplines, and for the practical trainings to master the key professional skills and accumulate practical experiences. The procedural module gives a special priority to the practical tasks with professional progress tests, case studies and business games.

Given hereunder is a sample professional progress test applied in the extracurricular health sports service course of the Physical Education Theory and Practice discipline: (1) Select one of the mass health sports events: futsal competitions for courtyard teams; "Orange Ball"; "Mom, Dad and I, a sports family"; a School Sports Festival, etc. (2) Make an health sports events implementation plan with a cost estimate, statute, scenario etc.

A Professional Master Class business game mimics the professional teaching service to train the key extracurricular health sports service design and management skills, with an emphasis on trainer-trainee communication, innovative technologies and service customization and individualization aspects. Prior to the practical sessions, the students are expected to master basics of the business game format, modern physical education service improvement methods; innovative technologies applicable in the extracurricular health sports service course; sports-prioritizing physical education service; spartan movement values; presidential competitive formats; Olympic education; physical education values and priorities; historical and cultural background of the modern physical education service etc. [2, p. 54].

Then students are expected to manage the selected health sports trainings in a master class format in the Physical Education Theory and Practice classes. The business game is finalized with the students' progress tests and analyses to rate the master class relevance and benefits; teaching creativity; compliance with the service format and standards; trainer-trainee interaction etc.

And the progress test module of the new model was designed to rate progress of the future physical education teacher in the extracurricular health sports service design and management knowledge and skills.

Conclusion. The study made it possible to develop the new practical training model to equip future physical education teacher with the extracurricular health sports service design and management knowledge and skills, with the training service designed on a modular basis to help analyze the logics and hierarchy of the training process.

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Practical training model for physical education teachers for social interaction skills building in 9-12 year-olds

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Abstract

Objective of the study was to develop and test benefits of a new practical training model for the future physical education teacher to make them fit for the social interaction skills forming extracurricular health sports service for the 9-12 year-olds.

Methods and structure of the study. The first stage of the study was designed to analyze the subject and the relevant key theoretical and practical provisions and outline the research concept. And the second stage was intended to work out a new additional practical training model for physical education teacher to train them for the social interaction skills forming extracurricular health sports service to the 9-12 year-olds. We sampled for the study run at the Physical Education Theory, Practice and Healthy Lifestyle Center [2] 45 students majoring in 44.03.01 Pedagogical Education discipline and specialized in physical education service.

Results and conclusions. The new social interaction skills forming extracurricular health sports service model for the 9-12 year-olds was tested beneficial as it facilitates the future physical education teacher progress in this modern professional service domain and effectively complements the standard curricula in the social interaction skills formation aspects.

Keywords: *social interaction skills, tweens, practical training model, extracurricular health sports service, physical education teacher.*

Background. The national educational system gives a special priority to practical training models to make a future physical education teacher highly fit for the social interaction skills building in 9-12 year olds (tweens). It should be emphasized that the traditional physical education teacher training curricula at pedagogical universities give the knowledgebase, skills and practical experience still limited and not always meeting the growing social demand [5]. In this context, as recommended by the provisions and concepts by V.A. Guruzhapov, S.I. Desnenko, I.A. Krutova, A.A. Margolis, T.I. Shukshina, F.G. Yalalov et al., we believe that the modern academic practical training models shall offer new training technologies and methodologies with an emphasis on the professional service simulation and immersion tools to facilitate progress of the future physical education teacher in the teaching knowledge, skills and experience in every service domain [1, 3-5].

Objective of the study was to develop and test benefits of a new practical training model for the future physical education teacher to make them fit for the social interaction skills forming extracurricular health sports service for the 9-12 year-olds.

Methods and structure of the study. The first stage of the study was designed to analyze the subject and the relevant key theoretical and practical provisions and outline the research concept. And the second stage was intended to work out a new additional practical training model for physical educa-

tion teacher to train them for the social interaction skills forming extracurricular health sports service to the 9-12 year-olds. We sampled for the study run at the Physical Education Theory, Practice and Healthy Lifestyle Center [2] 45 students majoring in 44.03.01 Pedagogical Education discipline and specialized in physical education service.

Results and discussion. Based on the above provisions, we developed and piloted a 36-hour additional practical training model for physical education teacher to train them for the social interaction skills forming extracurricular health sports service to the 9-12 year-olds. The model was piloted at Moscow State Pedagogical Institute and General Education Schools № 40, 10 and 11 in Saransk. The new model set the following goals: master basics of the age-specific social interaction skills for the age group; master the modern social interaction skills forming extracurricular health sports service for the age group; and master basics of the social interaction skills progress tests applicable in the trainings.

The social interaction skills forming extracurricular health sports service model includes the following two modules. Module 1 is designed to help the future physical education teacher master the social interaction skills theory for the age group on a competency-based basis, with the key notions and fundamentals – including the knowledge about the age specifics needed to be taken into account in the social interaction skills formation process; and the key professional and personal qualities of the physical education teacher for success in this teaching service. And Module 2 prioritizes practical training of the future physical education teacher at general education establishments. The physical education teacher is expected to practically master the basic social interaction skills forming extracurricular health sports service methods, techniques and tools. A special priority in the trainings is given to the methods to spur up the students motivations for the extracurricular health service and their interests in sports and social interaction skills; facilitate the teamwork; provide the personal role model to the students; and encourage their motivations for team health sports and school/ municipal and other competitions.

The model gives a special attention to the group health sports practices to facilitate the social interaction skills formation process, with the future physical education teacher learning the basic social interaction skills-forming extracurricular health sports service approaches and design principles and testing progress of the students in different health sports events: festivals, health days, joint trekking tours, group discussions, active games, sporting projects, etc.; with a special focus on the family contributions to and encouragements for extracurricular health sports service activity.

Trainings in the standard curriculum are complemented by the self-reliant practical trainings geared to: form the individual files/ portfolio of the social interaction skills forming extracurricular health sports service aids and materials (lectures, practical guidelines, video presentations) with an emphasis on developing motivations for social interaction skills in students; and social interaction skills progress testing and analyzing case studies to facilitate the practical service.

Upon the social interaction skills forming extracurricular health sports service piloting experiment, we run some of the post-experimental tests in the form of defenses of theses by the trainees in the optional education subjects/ projects. Most successful were the following projects: “The Enchanted Castle” health sports game; “We Choose a Healthy Lifestyle” role game, etc.; with every health sports project later on tested in the practical teaching service. The social interaction skills forming extracurricular health sports service piloting experiment was also finalized by a reflection analysis and future physical education teacher knowledge and skills tests. The future physical education teacher mastery in the social interaction skills forming extracurricular health sports service technologies was tested in the following aspects: core values and motivations for the social interaction skills forming extracurricular health sports service (with the physical education teacher expected to realize the importance and opportunities of the healthy lifestyle technologies for the students); cognitive resource (practical knowledge in the social interaction skills forming extracurricular health sports service technologies); experience and performance (reproducibility and application feasibility); reflexive assessment skills, including mastery in the social interaction skills progress rating test systems, etc. The post-experimental tests rated 75.5% of the sample highly skilled in the social interaction skills forming extracurricular health sports service technologies – that verifies practical benefits of the new training model.

Conclusion. The new social interaction skills forming extracurricular health sports service model for the 9-12 year-olds was tested beneficial as it facilitates the future physical education teacher progress in this modern professional service domain and effectively complements the standard curricula in the social interaction skills formation aspects.

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Technological competency training supplementary program for future physical education teachers

UDC 796.077.5

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Abstract

Objective of the study was to test benefits of the technological competency training supplementary educational program for future physical education teachers.

Methods and structure of the study. The 24-hour technological competency training supplementary educational program for future physical education teachers was piloted at the Physical Education and Healthy Lifestyle Applied Research Center [2]. We sampled for the study senior students (n=118) of Evseviev Mordovian State Pedagogical Institute majoring in 44.03.01 Pedagogical Education discipline and specializing in Physical Education Service. The sample progress was tested by the pre- versus post-experimental technological competency testing toolkit [3]. The 24-hour technological competency training supplementary educational program for future physical education teachers was designed to help the trainees master the health and fitness theory, practice and skills; develop the healthy lifestyle need; and master modern health and fitness technologies.

Results and conclusions. The new supplementary educational program includes the following two modules. Module 1 “Theoretical fundamentals of health and fitness technologies” offers theoretical lectures to build up the knowledgebase on the modern health and fitness technologies, their notions, classifications and selection/ application requirements. Individual progresses in learning are tested by personal interviews, knowledge tests, brain-rings etc. Module 2 "Technological provisions for health and fitness activities" is designed to put the technological competency of a future physical education teacher on a sound practical basis, with the modern health and fitness technologies mastered in practice.

The technological competency training supplementary educational program for future physical education teachers piloting experiment with the trainees’ progress tests gave us good grounds to rate the new supplementary educational program beneficial and recommend it for application in the future physical education teacher’s technological competency formation systems.

Keywords: *technological competency, physical education teacher, supplementary education, supplementary educational program.*

Background. In the context of the national educational system making a transition from the knowledge-prioritizing to the information-processing-and-competency prioritizing paradigm, the education community reports an objective need for revision of the existing educational service models. With reductions in the classroom hours, growth in the self-reliant studies and other innovations, the standard academic curricula are no more fully capable of meeting the future physical education teacher demand for modern technological competency; and, therefore, supplementary training curricula may be beneficial for covering the need for the still deficient educational service contents and procedures [1].

The future physical education teacher’s technological competency may be defined as the “integral vocational personal asset with specific values, priorities and motivations for successful professional service, with due knowledge in the modern educational service design and

management aspects including the personality-progress-logics-sensitive general education and specific physical education and sports and health physical education service method, models and tools" [3, p. 9].

Objective of the study was to test benefits of the technological competency training supplementary educational program for future physical education teachers.

Methods and structure of the study. The 24-hour technological competency training supplementary educational program for future physical education teachers was piloted at the Physical Education and Healthy Lifestyle Applied Research Center [2]. We sampled for the study senior students (n=118) of Evseviev Mordovian State Pedagogical Institute majoring in 44.03.01 Pedagogical Education discipline and specializing in Physical Education Service. The sample progress was tested by the pre- versus post-experimental technological competency testing toolkit [3]. The 24-hour technological competency training supplementary educational program for future physical education teachers was designed to help the trainees master the health and fitness theory, practice and skills; develop the healthy lifestyle need; and master modern health and fitness technologies.

Results and discussion. The new supplementary educational program includes the following two modules. Module 1 "Theoretical fundamentals of health and fitness technologies" offers theoretical lectures to build up the knowledgebase on the modern health and fitness technologies, their notions, classifications and selection/ application requirements. Individual progresses in learning are tested by personal interviews, knowledge tests, brain-rings etc. The learning process is facilitated by group discussions, with their topics echoing aphorisms and statements of great philosophers on health and healthy lifestyle. The tests make it possible to rate progress in the health and fitness theory, health and fitness technologies, their requirements, classifications and practical applications.

Module 2 "Technological provisions for health and fitness activities" is designed to put the technological competency of a future physical education teacher on a sound practical basis, with the modern health and fitness technologies mastered in practice. The practical trainings are geared to help the trainees master the health protection and improvement technologies to be able to design the actual needs specific health and fitness service systems. Learning progresses of the trainees are encouraged and tested by regular public defenses of the technological maps for the health physical education training sessions of their own design. Final tests include defense of individual health and fitness projects – in the following fields, for example: "Target physical education and sports service models for educational systems"; "Stretching exercises in the physical education curriculum"; "Adaptive physical education technologies for trainees with disabilities", etc.

The standard supplementary educational program training is supported by the self-reliant practices with the following tasks: compile an encyclopedia of the health and fitness technologies; present a health and fitness classifying cluster; select the most efficient active rest breaks and health and fitness minutes for standard educational service; offer a set of fitness aerobics exercises for the health sport lesson warm-up stage, etc. The final tests included defense of practical health and fitness case study portfolios including drafts of different education tools, health sport events, projects and initiatives; individualized adapted health sport services for students with disabilities; extracurricular physical education and sport programs, etc.

Upon completion of the technological competency training supplementary educational program piloting experiment for future physical education teachers, we tested the sample progress in a variety of technological competency aspects with a reflexive analysis. The pre- versus post-experimental technological competency test toolkit included the values and motivations test; cognitive resource test; practical operations test; and reflexive rating skills test [3]; with the individual test

Table 1. *Pre- versus post-experimental averaged technological competency test data: technological competency training supplementary educational program for future physical education teachers, %*

Tests	High		Basic		Acceptable	
	Pre-exp.	Post-exp.	Pre-exp.	Post-exp.	Pre-exp.	Post-exp.
Values and motivations	19,6	32,1	37,5	50	42,9	17,9
Cognitive resource	8,9	28,6	32,2	60,7	58,9	10,7
Practical operations	8,9	28,6	26,8	57,1	64,3	14,3
Reflexive rating skills	12,5	25	39,3	60,7	48,2	14,3
Averages	12,5	28,6	33,9	57,1	53,6	14,3

rates empirically classified into acceptable, basic and high: see Table 1 hereunder.

Conclusion. The technological competency training supplementary educational program for future physical education teachers piloting experiment with the trainees' progress tests gave us good grounds to rate the new supplementary educational program beneficial and recommend it for application in the future physical education teacher's technological competency formation systems.

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Research competitions in professional teacher training system of physical education department students

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Abstract

Objective of the study was to provide theoretical and experimental substantiation of the role and significance of research competitions within the professional teacher training system of Physical Education Department students.

Results and conclusions. At Mordovian State Pedagogical Institute named after M.E. Evseviev much attention is traditionally paid to the professional physical education teacher and coach training. The university has a multi-level training system aimed to improve the quality of the educational process, its practical orientation, and consistency in the educational and research processes. Among its elements, a special place belongs to the student research competitions. Having emerged as a form of encouragement of students' research activity, they quickly proved to be an important mechanism of formation and rating of the students' research competency level. The Physical Education Department was among the first structural units of the university that used the potential of research activities to solve a wide range of current problems and tasks of the physical education teacher and coach training.

This article is devoted to the analysis of the educational capacity, role, and importance of research competitions for enhancing the vocational training system of the Physical Education Department students. The results of the exploratory-experimental analysis showed that the complex and multi-level organization of student research competitions is related to the elements of the Physical Education Department student training system. In particular, it makes it possible to add more meta-subject project and research competences building focus in the educational programs, personalize educational trajectories, expand the methodological training of students, develop subjective activity and self-learning skills, which is important for improvement of the quality of higher education.

Keywords: *research developments, research competency, professional teacher training system, Physical Education Department, teacher training institute, research competitions.*

Background. The relationship between the level of research competency development of a future physical education teacher and the key characteristics of his readiness for studying, professional reflection, and innovative transformation of the teaching and coaching practices is the object of scientific interest of many Russian and foreign scientists [2]. The dynamically developing field of practical activity of the Physical Education Department graduates opens up a wide range of topical problems and tasks, the solution of which requires highly developed research competency and certain research experience. In addition, there is a growing trend in the individualization and personification of educational products and services. Research experience and research competences contribute, on the one hand, to better adaptation to the ever-changing professional environment, and on the other - to more efficient work in the mode of innovative development of the educational practice [3].

Objective of the study was to provide theoretical and experimental substantiation of the role and significance of research competitions within the professional teacher training system of Physical Education Department students.

Results and discussion. The analysis of the Russian and foreign university educational practices, as well as the results of the exploratory and experimental activities carried out at Mordovian State Pedagogical Institute revealed that research competitions are crucial for the students' research and learning-cognitive productivity. An integrated approach to planning and organizing students' research activities, development of the required scientific and methodological support offer considerable possibilities for research competitions in terms of improvement of the quality of professional physical education and sports teacher training [1].

The integrated approach involves systematization of research activities by defining the target indicators of students' research activities, planning of research work with students at all levels, including the activities of research associations and student government assets, scientific events for students, including training events aimed to build research competences (scientific schools, master classes, methodological seminars, etc.); development of methodological recommendations on mainstreaming the area of research, regulatory documents, and rules of organization and holding of student scientific events.

Annual research competitions are important in the determination of the ranking positions of both a student (and thereupon, realization of incentive measures) and a scientific supervisor of the student research association, performance of each teacher, department and faculty as a whole. Various forms of competitive presentation of the research developments, the results of which are found in the electronic portfolio of students and rating data of the departments, encourage physical education teachers to strengthen the research component of the educational process within the discipline or its module, different practices, including extra-curricular research work with students, as well as to strive for a good result.

The scientific and methodological support of training and involvment of students in research competitions is carried out through updating the directions and topics of student research, organization of consultations by the leading experts in planning and pursuance of research, as well as organization of various training activities (tutorials, seminars, master classes, round tables, trainings with curators of student research society and research team leads), additional educational programs for students on research and project activities [2].

Among the competitions arranged by the pedagogical institute on an annual basis are: "Student Scientific Research", "Best Student Researcher of the Year", "National Student Research Competition for Secondary Technical Schools and Higher Education Institutions", Student Science Festival, etc.

The student research competition aims to popularize research activities and modern scientific achievements among university students; improve the quality of scientific research; identify promising and support most relevant scientific researches. The competition involves on-line or off-line defense of research results. The degree of immersion in the research subject, the author's possession of the scholarly apparatus, the quality of presentation of the material, visualization of the research results, clarity of conclusions generalizing the speech, quality of answers, etc. are assessed during the competition. The competition "Best Student Researcher of the Year of M.Y. Evseviev Mordovian State Pedagogical University" aims to identify and encourage students who have proved themselves in research work; increase the research activity of student youth and involve them in current research; integrate scientific activities and educational process; form a personnel reserve of the university. Students' e-portfolios which represent the main research achievements and developments are evaluated. The competition results are aggregated in accordance with a wide range of nominations, which makes it possible to assess students' research abilities individually.

The Science Festival has proved its worth. It makes it possible to successfully solve the problems of popularization among students of scientific ideas and developments, involvement of young people in scientific work, as well as the definition of the priorities of student science and its role in the future teacher formation. The advantage of the Science Festival as a form of work with young people is the organization of informal communication of famous scientists and experts, whose activities are associated with the introduction of scientific developments and innovations, public figures, physical education teachers, health and safety education teachers, coaches, and students.

The festival program includes more than 50 lectures, master classes, presentations, and discussion areas. Of particular interest are the trend-session "Prospects for the Development of Student Science", design laboratories, networking sessions, quests, and intellectual tournaments. The moderators of various festival venues reveal the perspectives of the work, go public about forthcoming competitions and conferences, where students can take an active part and realize their ideas, show their knowledge, practical skills, and professional excellence.

To increase motivation and quality of management of scientific research work of students by the institute teachers, the competition "Best Student Research Association of Mordovian State Pedagogical Institute named after M.E. Evseviev" is held. The competition aims to improve the student research mechanisms; demonstrate the most significant achievements of

the student research associations; create a database of effective methods of student research; and share positive experience.

Overall, the comparison of the main performance indicators of students' research activities over the past two years shows a positive trend: the number of articles in the Russian journals reviewed by the Higher Attestation Commission increased by 15%, the number of articles in the scientific journals - by 39%, the number of patents registered by RosPatent – by 30%. In 2019, the number of applications to the open competitions for the best scientific work of students, held on the orders of the federal executive authorities, doubled. There was a 35% increase in the number of medals, diplomas, and merit certificates obtained by students during the open competitions.

Conclusion. The analysis of the results of the exploratory and experimental activities carried out at the Physical Education Department of Mordovian State Pedagogical Institute revealed that integrated and multi-level (department, faculty, student research associations, university, inter-university events) organization of student research competitions makes it possible to improve individual elements of the faculty's training system (strengthening of interdisciplinary links in the teacher education, focus of the educational programs on the formation of metasubject project-research competencies; individualization of education trajectories; deepening of methodological training of students, mastery by students of universal learning-cognitive actions and algorithms in research and design activities; expansion of general and professional awareness; development of subjective activity and learning-cognitive autonomy of students; raising the level of educational achievements, their personalization; forming a value-based attitude towards research, etc.), which is a significant factor in improving the quality of professional teacher training of future teachers and coaches.

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Formation of critical thinking competences within physical education personnel training system

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Abstract

Objective of the study was to substantiate the critical thinking competence building educational technology within the physical education personnel training system.

Results and conclusions. The article presents an analysis of modern approaches to the building critical thinking competences in university students majoring in physical education. The presented technology was based on the following stages: involvement, comprehension, and reflection.

Involvement: this stage is characteristic of the beginning of the physical education lesson. At this stage, the students are offered to define the subject of the lesson and the significance of the preparatory and main parts based on individual fragments presented by the teacher.

Comprehension: at this stage, new information is given to the students.

Reflection is the final part of the lesson. As a rule, students here express their opinion about the lesson, assess their condition. They are asked to make self-evaluation and are set homework.

This competency-building technology is based on the development of tasks that are not based on the specific knowledge of students, which makes it possible to determine their critical attitude towards the information received, rather than the degree to which they master the material.

Using this type of tasks one can increase student's potential, integrate the acquired knowledge, develop independent behavior, and identify the most gifted students.

Keywords: *physical education, students, educational technology, critical thinking, competences, physical education personnel training.*

Background. In the physical education and sport sector, the level of formation of critical thinking skills is defined by the following qualities: independence of thought, depth of thought, broad-mindedness, mental flexibility, critical thinking, and mental speed. Independence of thought is the ability of future physical education and sports specialists to see a problem through, set new goals and achieve them on their own. Future physical education teachers and sports coaches must also be able to understand and anticipate situations related to their physical education and sports activities [2, 5, 6].

The critical thinking skills necessary for physical education and sports activities are seen as the ability to take a correct view of the current conditions and activities, to find the new that would be best matched to the physical education and sports environment [1, 3, 4].

In this regard, it is particularly important to consider the issue of critical thinking skills building in university students to prepare them for their professional activities.

Objective of the study was to substantiate the critical thinking competence building educational technology within the physical education personnel training system.

Results and discussion. *Analysis of the educational technology and technology-related discussion*. An important element of the physical education personnel training process is the development of the stu-

dents' ability to make use of the acquired competence and skill to apply the educational technology for critical thinking skills building.

The presented technology was based on the following stages: involvement, comprehension, and reflection.

The *involvement stage* is characteristic of the beginning of the physical education lesson. At this stage, the students are offered to define the subject of the lesson and significance of the preparatory and main parts based on individual fragments presented by the teacher.

At the *comprehension stage*, new information is given to the students. When mastering the motor action execution technique the trainees are offered various options for its assimilation: description, pattern, video fragments, execution of the motor action. Different training methods are used for this purpose. Further work on the motor action training is critical here. The training outcome is to be evaluated by testing the mastered motor action during the competitions. The execution of this action algorithm makes it possible to build the trainees' critical thinking skills and the ability to apply the acquired knowledge in practice.

Reflection is the final part of the lesson. Normally here students express their opinion about the lesson, assess their own condition. They are asked to make self-evaluation and are set homework.

Communication (foundations of communication theory) is an effective synchronous and diachronous interaction aimed to transmit information from one subject to another.

Collaboration, or cooperation, is seen as a team work of two or more people or organizations in one field aimed to achieve common goals, while sharing knowledge, learning, and finding consensus.

Communication and collaboration in the physical education and sports sector have a number of distinctive features and can be addressed in two ways:

1. *Relationships during the direct interpersonal interaction (see Figure 1).*
2. Mutual, indirect influence on the partners in communication (system of signs).

This competence allows the participants of the physical education process to not only exchange information but also understand it. Communication between the participants is an integral part of physical education and sports activities, which affects their progress and outcome.

The level of formation of communication competence is determined by the following indicators: willingness to communicate, i.e. readiness to interact; adaptation to the communication objective and context, as well as the partner in communication, i.e. the ability to choose ways and methods of communication as suited the situation; persuasive communication, i.e. the application of the means and methods of communication in the furtherance of the set goal.

The level of formation of the collaboration competence of physical education and sports specialists is determined by several factors:

- understanding and acceptance of common objectives for achieving a training outcome;
- team work;
- achieving the targets set and fulfilling obligations;
- proactive and independent achievement of the set targets, psychological support of the team members.

The mastery of the presented educational technology by the sports university students will enable them to introduce new forms of organization of the educational activity.

Conclusion. This competency-building technology is based on the development of tasks that are not based on the specific knowledge of students, which

Physical education	Sports
Trainee – trainer	Coach – coach
Trainer – trainee	Coach – athlete
Trainee – trainee	Athlete – athlete
	Athlete – team
	Athlete – opponent
	Athlete – fan

Figure 1. *Communication between the subjects of physical education and sports activities*

makes it possible to determine their critical attitude towards the information received, rather than the degree to which they master the material.

Using this type of tasks one can increase student's potential, integrate the acquired knowledge, develop independent behavior, and identify the most gifted students.

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Coordination determinants of technical skills of young female tennis players

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Abstract

Objective. The aim of this study was to obtain knowledge on coordination determinants of technical skills of female tennis players aged 9 and 11. Material and methods. The study included female tennis players (n= 60), body height (9 yrs ± 6.1 -137± 5.7 cm; 6; 11 yrs±7.2 -148± 5.2 cm), body mass (9 yrs - 34± 1.9 kg; 11 yrs - 43± 2.3 kg).

To assess the female tennis players' technical skills the test of 100 balls was applied. To control coordination motor abilities, the following tests were used: certain EUROFIT tests (the flamingo test, tapping the discs), the Spalding slalom running test, the shuttle run test, the Spider test, jumps over a skipping rope, jumps in the hexagon, the Starosta test, the eye-hand test, the test of simple reaction and the test of complex reaction. Results. It was discovered that in the group of 9-year-old female tennis players, the simple reaction test result demonstrates the best predictive properties (it accounts for 19% of the variance in the test of 100 balls). In the group of 11-year-old female tennis players, the result of the shuttle run test independently accounts for 38% of the variance of the dependent variable. Conclusion. The effectiveness of performing the test of 100 balls depends on different predictors of coordination motor abilities.

Keywords: *tennis, 100 balls test, coordination motor abilities.*

Introduction. Tennis is regarded as the type of sport in which, in addition to showing a high level of concentration and anticipation of the opponent's behaviour, technical skills as well as their coordination determinants play a key role.

Finding ways to achieve great results of sport performance is one of the biggest challenges of modern sport. The willingness to meet this challenge forces us to constantly search for and deepen our knowledge of the phenomena accompanying the optimization of the process of training in sport at different stages of advancement [1-3]. Many professionals believe that in the long-term process of training a young player, apart from teaching and learning about techniques and tactics, it is important to develop fundamental and specific conditioning and coordination motor abilities. The development of the latter favours the development of fundamental motor skills, including the basics of technique, which is useful in the subsequent stages of training and makes it possible to achieve a higher level of sports mastery [4-6].

There is no doubt that coordination skills are of fundamental value to a tennis player. In the studies on the optimization of the training process, many authors attempted to identify factors determining the level of sports performance in tennis, and they pointed to their diversity. Some of them attribute an important role to such coordinating abilities as body balance, rhythmization, eye-hand coordination, simple and complex reaction time, kinaesthetic differentiation of movements, time of a single movement, frequency of movements and agility [7-10].

Therefore, it seems useful to search for coordination determinants of technical skills, which will make it possible to bring additional information to the general training technology and to optimize the training pro-

cess of female tennis players aged 9 and 11 a comprehensive stage.

Material and methods. The study included female tennis players (n= 60), body height (9 yrs ± 6.1 -137± 5.7 cm; 11 yrs±7.2 - 148± 5.2 cm), body mass (9 yrs - 34± 1.9 kg; 11 yrs 43± 2.3 kg). The players who took part in the study trained tennis three times a week in the clubs of Podlaskie region. The participants were divided according to their age categories.

Technical skills of the female tennis players were evaluated using the test of 100 balls. To control coordination motor abilities, the following tests were applied: some EUROFIT tests (the flamingo test, tapping the discs), the Spalding slalom running test, the shuttle run test, the Spider test, jumps over a skipping rope, jumps in the hexagon, the Starosta test, the eye-hand test, the test of simple reaction and the test of complex reaction. The normality of distributions was evaluated with the Shapiro-Wilk test. As they were normal, parametric tests were applied. Subsequently, correlation analyses were carried out using multivariate linear regression analyses with the stepwise method of inserting predictors into the model. The intention was to find out which coordination model in the two-age groups would be the best to anticipate technical skills. The predictors introduced in the analysis were the results of the subsequent coordination tests, and the dependent variable was the result of the test of 100 balls.

Results. In the group of 9-year-old female tennis players, the simple reaction test result had the best predictive properties (it accounted for 19% of the variance in the test of 100 balls). Adding the jump measurement results to the model led to the fact that a total percentage of the explained variance was 24% (table 1).

In the group of 11-year-old girls, the result of the shuttle run test accounted for as much as 38% of the variance of the dependent variable. However, adding the Spalding slalom running test and the test of tapping the discs to the model resulted in a statistically significant increase in the percentage of the explained variance (by 8% and 4%) to the level of 47% of variations explained by the developed model that consisted of three such predictors. It is worth noting that they are all negatively correlated with the dependent variable. The lower the scores in the test of tapping the discs, the Spalding slalom running test and the shuttle run test, the better the scores in the test of 100 balls in this age group.

Conclusion. The effectiveness of performing the test of 100 balls depends on different predictors of coordination motor abilities. It is noteworthy that in the group of 9-year-old female tennis players, 19%

Table 1. *Results of the linear regression analysis in the groups of 9- and 11-year-old female tennis players that aimed to find coordination predictors of high-level technical skills (the test of 100 balls)*

		B	SE	β	R^2	ΔR^2	$F_{changes}$	$P_{changes}$
9 yrs	**model 1**				0.19	0.19	13.62	<0.001
	(Constant)	-106.64	58.51					
	Simple reaction test	4.47	1.21	0.44***				
	model 2				0.24	0.07	5.78	0.019
	(Constant)	-45.51	61.72					
	Simple reaction test	4.78	1.17	0.47***				
	Jumps in hexagon	-4.75	1.98	-0.27*				
11 yrs	**model 1**				0.38	0.38	36.24	<0.001
	(Constant)	522.08	59.81					
	Shuttle run test 5 x 8.23m	-26.34	4.38	-0.62***				
	model 2				0.44	0.08	8.07	0.006
	(Constant)	586.92	60.91					
	Shuttle run test 5 x 8.23m	-17.58	5.16	-0.41**				
	Spalding slalom running test	-16.55	5.82	-0.34**				
	model 3				0.47	0.04	4.03	0.050
	(Constant)	622.21	61.90					
	Tapping the discs	-3.04	1.52	-0.19*				
	Shuttle run test 5 x 8.23m	-16.40	5.06	-0.39**				
	Spalding slalom running test	-15.59	5.70	-0.32*				

** – $p < 0.05$; ** – $p < 0.01$; *** – $p < 0.001$*

of the variance is explained by the test of simple reaction (predictor), and 24% – by the test of simple reaction and jumps in the hexagon. In turn, in the group of 11-year-old female tennis players, the predictors explaining the variance were as follows: the shuttle run test (38%), the shuttle run test and the Spalding slalom running test (44%), the shuttle run test and tapping the discs (47%). The findings confirm the significance of the selected tests and their prognostic value.

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Hypoxic-hypercapnic training-based correction of functional state of qualified athletes

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Abstract

Objective of the study was to substantiate the need for a differentiated approach to the correction of the functional state of qualified athletes using hypoxic-hypercapnic training.

Methods and structure of the study. The study was carried out at the premises of the state-financed institution "Sports Medicine Center", Crimea, in the period from 2015 to 2017, with the informed consent of the subjects and after the verdict of the ethics committee. Sampled for the study were the 19-22 year-old qualified team athletes (n=100) and combat athletes (n=100). The authors rated their cardiorespiratory system functionality in the transitional period of the one-year training cycle, which was followed by the hypoxic-hypercapnic training course for 83 athletes. The course consisted of 10 training sessions, each with three sets of 5, 6, and 7 minutes (18 minutes in total), respectively, with a 5-minute rest break inbetween.

Results and conclusions. When identifying the differences in the functional reserves of the myocardi-um, it was the T-wave symmetry rates (βT) that were the most informative. There were statistically significant relationships between MOC/kg and $PETCO_2$ in the combat athletes with all breathing pat-terns. After the hypoxic-hypercapnic training course, the initial hypocapnic athletes were found to have expanded myocardial reserve and increased aerobic capacity of the body. The βT value decreased by 6% ($p<0.001$), the MOC/kg value increased by 10% ($p<0.01$). In the group with the initial hypocapnic type of ventilation, no changes in MOC/kg were found, but the βT value decreased by 10% ($p<0.001$).

Keywords: *cardiorespiratory system, hypocapnia, functional reserves.*

Background. Constant psychophysical stresses in qualified athletes often lead to the overstrain of the functional systems of the body, especially the cardiorespiratory system, which increases the risk of failure of adaptation and reduced working capacity (A.V. Mikhaylova, 2009). Therefore, timely diagnostics and correction of the resultant dysfunctional conditions make it possible to preserve the athlete's health and high fitness level. As known, excessive pulmonary ventilation is a factor that limits efficiency of the muscle activity and may cause tension in the cardiovascular system (N.A. Aghajanyan, 2000). Consequently, a differentiated approach based on the analysis of divergences of different parameters of the cardiovascular and respiratory systems is essential in the planning of the correctional impacts.

Objective of the study was to substantiate the need for a differentiated approach to the correction of the functional state of qualified athletes using hypoxic-hypercapnic training.

Methods and structure of the study. The study was carried out at the premises of the state-financed institution "Sports Medicine Center", Crimea, in the period from 2015 to 2017, with the informed consent of the subjects and after the verdict of the ethics committee. Sampled for the study were the 19-22 year-old qualified athletes from team sports (n=100) and combat athletes (n=100). The authors rated their car-

Table 1. *T-wave symmetry rates (β_T) in primary survey of qualified athletes depending on type of lung ventilation*

Ventilation-type-based subgroups	Team athletes (n=100)		Combat athletes (n=100)		p
	Number of athletes, % (4)	β_T, u. (5)	Number of athletes, % (6)	β_T, u. (7)	
Normocapnia (1)	65	0.58±0.01	52	0.63±0.01	5-7 (v0.01)
Hypocapnia (2)	25	0.71±0.01	26	0.74±0.02	-
Hypercapnia (3)	10	0.69±0.03	22	0.73±0.04	4-6 (<0.05)
P	1-2 (<0.01) 1-3 (<0.001)	1-2 (<0.001) 1-3 (<0.01)	1-2 (<0.05) 1-3 (<0.01)	1-2 (<0.001) 1-3 (<0.001)	

diorespiratory system functionality in the transitional period of the one-year training cycle, which was followed by the hypoxic-hypercapnic training course for 83 athletes. The course consisted of 10 training sessions, each with three sets of 5, 6, and 7 minutes (18 minutes in total), respectively, with a 5-minute rest break inbetween.

Results and discussion. We defined the specifics of the respiratory patters in the athletes by the carbon dioxide content in the last portion of the exhaled air (Table 1).

No differences were observed between the team athletes and combat athletes in terms of the distribution of the hypocapnic and normacapnic types of lung ventilation. At the same time, the normacapnic type of ventilation was typical of more than 50% of the subjects in both groups.

Conspicuous is the fact that the hypercapnic type of ventilation was more typical of the combat athletes than of those from team sports – the difference was twice as big ($p<0.05$). In the hypocapnic subgroup, the T-wave symmetry rate (β_T) was significantly higher compared with the normacapnic subgroup regardless of the focus of the training process. Thus, the degree of reduction of the cardiac reserves in the second subgroup of team athletes was the highest – 22% ($p<0.01$) as opposed to the first subgroup. A less pronounced difference of 18% ($p<0.05$) was observed in the third subgroup. Among the combat athletes, the rates of reduction of the functional reserves of the myocardium in terms of β_T were as follows: 17% and 15% ($p<0.001$) in the hypocapnic and hypercapnic subgroups respectively as compared to the normacapnic subgroup. The correlation relationship between $P_{ET}CO_2$ and MOC/kg in the team athletes with the normacapnic type of lung ventilation was at the level $r=0.63$ ($p<0.01$), while in the other two subgroups, the correlation was not statistically significant. A similar correlation analysis revealed a correlation between $P_{ET}CO_2$ and MOC/kg in all subgroups of combat athletes: $r=0.71$ ($p<0.01$) in the first and second subgroups and $r=0.77$ ($p<0.001$) in the third one The hypocapnic subgroup subjects were found to have the low levels of physical working capacity and aerobic capacities. At the same time, their MOC/kg rates did not exceed 48 ml/min/kg. The identified patterns indicated the need to differentiate athletes by the lung ventilation type to take further corrective actions aimed to increase the myocardial reserve and aerobic potential of the body.

The respiratory training had the most positive effect on 47 (92%) out of 51 athletes with initial hypocapnia. Their breathing pattern changes towards

Table 2. *Dynamics in $P_{ET}CO_2$, MOC/kg and β_T rates in qualified athletes depending on lung ventilation type before and after respiratory training course (M±SX), n=200*

Ventilation-type-based subgroups		Indicators		
		$P_{ET}CO_2$, mmHg	MOC/kgml/min/kg	β_T, u.
Normocapnia (n=117)	control	42.1±1.6	58.1±2.6	0.61±0.01
Hypocapnia (n=51)	before	33.1±1.5	48.1±1.2	0.73±0.04
	after	39.2±1.3	53.4±1.1	0.69±0.02
P		p< 0,01	p< 0.01	p<0.001
Hypercapnia (n=32)	before	49.5±2.3	53.6±1.2	0.72±0.08
	after	43.1±1.5	54.0±1.5	0.65±0.03
p		p<0.05	–	p<0.001

Note. Significance of differences in the test rates before and after the respiratory training course.

an energy-efficient reduction of the respiration rate: by 20.2% ($p<0.05$) at rest and by 25% ($p<0.01$) under the physical load of 250 W. Against this background, an increase in the myocardial reserves and aerobic capacities was observed. Thus, the β_T value decreased by 6% ($p<0.001$), while the MOC/kg rate increased by 10% ($p<0.01$) (Table 2).

In 30 (92%) out of 32 athletes with initial hypercapnia, the transition to the normacapnic ventilation was accompanied by a reduction in the level of tension of myocardial contractility regulation mechanisms, which was recorded by means of phasometry characterizing cardiac electrical activity. It was found that the β_T value decreased by 10% ($p<0.001$). It should be noted that an upward trend was observed in the MOC/kg rate; however, the changes were statistically insignificant.

Conclusion. The CO_2 content in the last portion of the exhaled air and the phasometric rate can act as markers of the mechanisms that determine the athlete's aerobic potential. Obviously, the respiratory training should be planned and conducted employing a differentiated approach based on the type of lung ventilation.

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Effects of dosed physical loads on hormonal changes and oxygen exchange in athletes

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Abstract

Objective of the present study was to identify the dynamics of the substrate and hormonal changes in highly-skilled athletes specializing in middle-distance running and former track athletes.

Methods and structure of the study. This study involved the highly-skilled athletes specializing in track and field athletics, middle-distance running, and former track athletes, who had retired from elite sports. They were subject to an exercise stress test to muscular failure. The physiological and biochemical measurements were taken.

Results of the study and conclusions. It was found that the response of the hormone system to physical loads in the athletes who had retired from elite sports differed from that in the active athletes. Adaptation to physical loads was not maintained in the retired athletes. The effects of somatotropin and glucagon on the metabolic processes under physical loads were found to be accompanied by the activity of a sufficiently wide range of catabolic hormones - the hormones of the anterior pituitary lobe, cortex of the adrenal glands, and catecholamines.

Keywords: *track athletes, hormones, metabolic substrates, insulin, glucagon, unesterified fatty acids, somatotropin, glycerine.*

Background. There is currently a fairly large number of works on the hormonal dynamics under physical loads [1-3]. Such peptide hormones as insulin, somatotropin, and glucagon are known to be crucial in mobilizing the energy resources of the human body [3-5]. The study of the dynamics of exercise-related changes in the plasma hormone concentrations in active elite athletes and those retired from elite sports can be of great relevance for assessing the sports performance and health status of elite athletes.

Objective of the study was to identify the dynamics of the substrate and hormonal changes in highly-skilled athletes specializing in middle-distance running and former track athletes.

Methods and structure of the study. The experiment under the study was run in the Muscular Activity Bioenergy Research Laboratory of the N.I. Volkov Sports Biochemistry and Bioenergy Department of Russian State University of Physical Education, Sports, Youth and Tourism. Sampled for the experiment were the active (n=12) and retired (n=10) athletes specializing in middle-distance running. The subjects were apparently healthy and after a doctor's permission gave their informed consent to participate in the experiment. The active and former athletes performed the same load – a standard exercise stress test to failure. The test lasted from 12 to 15 minutes. The subjects' heart rate and gas exchange parameters were recorded at rest, during the test and during the first 10 minutes of recovery. In addition, venous blood samples were drawn at rest, at the moment of failure, and during the 3rd and 10th minutes of recovery to determine the insulin, somatotropin, glucose, glycerine, and unesterified fatty acids concentrations. We measured the lactic acid concentrations in the capillary blood and catecholamines and their precursors in the urine. The radioimmunoassay and fluorometric methods were applied.

Results and discussion. The study data and analyses showed that during the exercise stress test to failure, the volume of the workload performed by the former athletes was on average 148.4+4.56 kg-m/kg and that the average duration of their work was 10.4+0.23 minutes, while in the group of active athletes, the workload volume was 275.5+8.34 kg-m/kg and the average work duration was 14.91+0.32 minutes. There were statistically significant differences between the active and former athletes in terms of several physiological indicators (see Table 1).

It is shown that the values of oxygen demand, oxygen supply, maximal oxygen consumption, maximal oxygen pulse, and maximum ventilatory equivalent for oxygen in the active athletes were statistically significantly higher than in the former athletes.

The results obtained when analyzing the dynamics of changes in the hormone and energy substrate concentrations in the active and former athletes in the initial state, immediately after the test, showed that the insulin level at rest was slightly lower in the active athletes than in those who had retired from elite sports. At the same time, the glucagon concentration was higher in the active athletes, but the differences were insignificant. Except for the glycerine level, no significant differences were found between the two groups of athletes when measuring the metabolic substrate concentrations. The glycerine concentration in the active athletes was lower than in the former ones ($p<0.05$).

At the moment of failure to perform an exercise further, the insulin level decreased in both groups, while the concentrations of somatotropin, unesterified fatty acids, glycerine, glucose and glucagon increased. The insulin level in the active athletes was lower than in those who had retired from elite sports. There was a significant increase in the somatotropin and glucagon concentrations. When analyzing the individual characteristics of hormones and metabolites, the former athletes were found to have a greater individual variation than the active athletes. For example, some retired athletes were found to have the glucagon concentration increased, while in others it decreased. The post-load glucose concentration in the active athletes increased significantly versus the baseline. In both groups, there was a significant increase in the unesterified fatty acids and glycerine concentrations as compared to the baseline data, but the intergroup differences were insignificant.

The identified dynamics of changes in the hormone and metabolic substrate concentrations during the recovery period were as follows. During the 3rd minute of recovery, the insulin, somatotropin and unesterified fatty acid levels were higher in the active athletes than in the former ones ($p<0.05$). In terms of other parameters, the differences detected during the 3rd minute of recovery were insignificant. By the 10th minute of recovery, the blood insulin of the active athletes remained higher as compared to those retired from elite sports. The somatotropin level was also higher in the active athletes ($p<0.05$). The unesterified fatty acids level during the 3rd minute of recovery decreased in the group of active athletes, while in the group of former athletes it increased.

Therefore, it can be said that the results obtained during the study indicated the activation of the somatotropin and glucagon secretion in response to the physical load in both groups. This activation was more pronounced in the active athletes. The physiological significance of this reaction seems to lie in the hormone-induced mobilization of the energy substrates from fat and liver depots to ensure the working muscles' demand. Since the metabolic substrate level results from completely different processes of their mobilization, it is fair to say that the speed of one process prevails over the speed of another. During the exercise stress test to failure, the rate of mobilization of unesterified fatty acids, glucose and glycerine was higher than the rate of their utilization, which was reflected in the increased concentration of metabolic substrates in response to the exercise. Along with the activation of the somatotropin and glucagon secretion, the mobilization of energy substrates is aided by the decrease in the insulin level associated with the

Table 1. *Dynamics of oxygen metabolism values in active and retired elite athletes, M±m*

Indicators	Group I (active athletes)	Group II (former athletes)
Oxygen demand, ml/kg	609.4±27.98**	385.2±15.23
Oxygen supply, ml/kg	512.4±21.6**	281.5±11.36
Oxygen debt, ml/kg	107.4±8.45	94.64±8.13
Maximal oxygen consumption, ml/kg·min	63.5±1.43*	50.4±1.10
Maximal oxygen pulse, ml/beats	25.6±0.45**	19.64±0.67
Oxygen cost of work, ml/kg-m	1.88±0.16	1.93±0.05
Maximum ventilatory equivalent for oxygen, ml/kg-m	0.23±0.07*	0.36±0.04

Note. * – $p<0.05$; ** – $p<0.01$.

suppression of the secretory activity of the β– cells of the pancreas and enhancement of the receptor binding of this hormone in the working muscles. The decreased insulin secretion may also be due to the activation of the sympathoadrenal system under physical loads, and this process was observed in both study groups.

The data obtained indicated that such metabolic reactions as activation of lipolysis, glycogenolysis, and other catabolic processes are associated with increased glucagon – and somatotropin-producing cell activity. It can be assumed that the effects of somatotropin and glucagon on the metabolic processes occurring under exercise are accompanied by a sufficiently wide range of catabolic hormones – the hormones of the anterior pituitary lobe, cortex of the adrenal glands, and catecholamines. At the same time, the withdrawal of one of the regulatory links can be compensated by the activation of other links. Increasing physical load to failure breaks the pattern of decrease in the training process of the amplitude of hormonal shifts in response to the exercise of constant power and duration. Extreme loads require the mobilization of all body reserves, and in this case, the physical fitness level may be expressed in the maximal activation of all the hormonal regulation systems. Conspicuous is the fact that in terms of economization, the hormonal system of the athletes who have retired from sports is, in a way, approaching that of people who have never been into sports.

Conclusions. The values of oxygen demand, oxygen supply, maximal oxygen consumption, maximal oxygen pulse, and maximum ventilatory equivalent for oxygen in response to physical loads were significantly higher in the active athletes than in the former ones. Under the influence of dosed physical loads, the somatotropin secretion increased in both study groups. This activation was most pronounced in the active track athletes, which was associated with the hormone-induced mobilization of the energy substrates from fat and liver depots to ensure the working muscles' demand. Extreme loads require all reserves of the body being mobilized. Moreover, the physical fitness level is expressed in the maximal activation of all the systems of hormonal regulation.

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Comparative analysis of physiological parameters in healthy young males with different levels of load tolerance in cycle ergometer test

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Abstract

Objective of the study was to identify the impact of motor activity of young males on gas exchange, external respiration function, and cardiovascular system during the load testing.

Methods and structure of the study. Sampled for the study were the 17-21 year-old young males, permanent residents of the Magadan Region, with different sports levels: usual (low load tolerance) and high (high load tolerance) motor activity modes. The Medgraphics VO2000 metabolimeter was used to record the subjects' heart rate, gas exchange and external respiration rates in a state of rest and on the 2nd and 3rd minutes of the cycle ergometer test.

Results and conclusions. The analysis of the dynamics of changes in the respiratory coefficient, comparison of the oxygen consumption and carbon dioxide emission rates, as well as the ventilatory equivalent for oxygen and carbon dioxide in the average motor activity group, revealed that anaerobic (ventilatory) threshold was reached between the 2nd and 3rd minutes of testing, which was not observed in the high motor activity group of subjects during the cycle ergometer test.

It was found that a number of characteristics in the low load tolerance males indicated the inefficient cardiovascular functioning against the background of reduced oxygen consumption with high exhaled oxygen concentration, which was most evident at the peak of cycle ergometer test load. Such changes in the physiological systems of the body can be used as a prognostic criterion for assessing the level of physical fitness and training of young males during the 3-minute cycle ergometer test.

Keywords: *young males, cycle ergometry, metabolism, cardiovascular system.*

Background. Physical activity and health status are known to be strongly associated. Thus, the rise of the physical fitness level may have additional health benefits [5]. Physical load tolerance is currently used as a synonym for physical working capacity, which is now rated in the cycle ergometer test and is deemed to be the total physiological capacity of the body [3]. The ability to perform muscle work is among the most significant biological functions; it is determined based on the oxygen consumption rate and reflects the aerobic potential and physical working capacity of the body [1].

Objective of the study was to identify the impact of motor activity of young males on gas exchange, external respiration function, and cardiovascular system during the load testing.

Methods and structure of the study. Sampled for the study were the 17-21 year-old young males, permanent residents of the Magadan Region. All subjects were split into 2 groups based on their fitness level: Group 1 (n=36) – the average level of motor activity – young males engaged in physical training and sports activities under the academic physical education curriculum; Group 2 (n=32) – the high level of motor activity – young males having the sports qualifications of Candidate Masters of Sport and higher. The young males were subjected to a cycle ergometer test to be performed at the

load power of 900 kg-m/min (150 W) and a constant pedaling speed of 60 rpm. Our earlier studies [2] showed that the load tolerance level can be determined in the 3rd minute of the cycle ergometer test, based on which we reduced the pedaling time to 3 minutes. The Medgraphics VO2000 metabolimeter (USA) was used to record the subjects' heart rate, gas exchange and external respiration rates in a state of rest and in the 2nd and 3rd minutes of the cycle ergometer test.

The parametric data processing results are presented as a mean and an error in mean (M±m). The statistical significance of differences was determined using the Student t-test for dependent and independent samples. The research protocol was approved by the Bioethical Commission of the Federal Publicly Funded Institution "Science Institute of Biological Problems of the North of the Far Eastern Branch of the Russian Academy of Science" (No.001/019 of 29.03.2019).

Results and discussion. The analysis of the data obtained revealed that the young males from Group 1 had high values of heart rate, respiration rate, VE/VO_2, and VE/VCO_2 against the low oxygen utilization coefficient (O_2UC). The cycle ergometer test caused significant changes in gas exchange and external respiration function; however, the degree of changes depended on the load tolerance level. In the 2nd minute of testing, the number of significant differences went up: the study group with the moderate motor activity level had lower values of tidal volume, respiratory minute volume, VO_2, VE/VCO_2, which was observed against the higher respiratory quotient (RQ) and heart rate (HR).

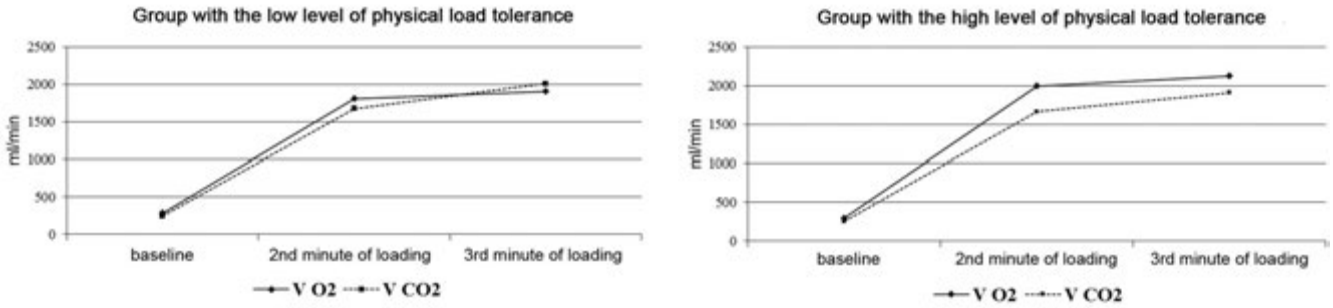
Further load-specific changes in the 3rd minute of testing turned out to be even more significant. Thus, the young males from Group 2 were found to have lower values of heart rate, RQ, VCO_2, VE/VO_2, and $FETO_2$ against significantly higher values of VO_2, VE/VCO_2, and RQ. In the 3rd minute of testing, significantly higher O_2 and CO_2 concentrations in the exhaled air were characteristic of the subjects with the moderate level of motor activity.

At each stage of the cycle ergometer test, the heart rate values were lower in the group of young males with the high level of motor activity. The chronotropic load efficiency was 61.2% in Group 1 and 48% in Group 2. The data obtained showed a 28% increase in the chronotropic response in the study group with the moderate level of motor activity, which is deemed a display of inefficient cardiovascular system response to the workload (see Table 1).

In the group of young males with the high motor activity level, the RQ values in the 3rd min of the cy-

Table 1. *External respiration and gas exchange rates in healthy young males with average and high levels of motor activity*

Indicators	Stages of the cycle ergometer test			Significance level	
	Baseline	2nd min	3rd min	Baseline – 2nd min	2nd min – 3rd min
Group with moderate level of motor activity (with low exercise tolerance level)					
HR, bpm	*70.9±0.4	*140.1±0.5	*151.1±0.4	p<0.001	p<0.001
RQ, c.u.	0.85±0.01	*0.92±0.01	*1.07±0.01	p<0.001	p<0.001
V CO_2, ml/min	245.9±7.3	1672.5±30.1	*2011.4±26.8	p<0.001	p<0.001
V O_2, ml/min	288.7±7.3	*1809.1±24.9	*1905.9±26.8	p<0.001	p<0.01
VE/VCO_2, c.u.	*34.3±0.6	*25.3±0.3	*25.1±0.3	p<0.001	p=0.28
VE/VO_2, c.u.	*29.1±0.5	23.3±0.3	*26.8±0.4	p<0.001	p<0.001
FET CO_2, %	3.74±0.06	4.99±0.06	*5.06±0.04	p<0.001	p=0.17
FET O_2, %	16.48±0.09	15.43±0.06	*15.96±0.06	p<0.001	p<0.001
O_2UC, c.u.	*35.4±0.7	43.4±0.6	*37.8±0.5	p<0.001	p<0.001
Group with high motor activity level (with high exercise tolerance level)					
HR, bpm	61.2±1.6	123.5±1.5	129.2± 1.2	p<0.001	p<0.001
RQ, c.u.	0.85±0.02	0.85±0.01	0.93±0.01	0.00	p<0.001
V CO_2, ml/min	255.2±16.9	1662.1±46.5	1908.5±32.3	p<0.001	p<0.001
V O_2, ml/min	297.4±10.2	1956.4±42.3	2126.2±44.2	p<0.001	p<0.05
VE/VCO_2, c.u.	32.8±0.6	27.2±0.5	26.1±0.5	p<0.001	p<0.05
VE/VO_2, c.u.	27.5±0.5	23.2±0.5	24.7±0.6	p<0.001	p<0.05
FET CO_2, %	3.89±0.08	4.83±0.08	4.96±0.03	p<0.001	p<0.001
FET O_2, %	16.25±0.09	15.22±0.09	15.41±0.07	p<0.001	p=0.26
O_2UC, c.u.	37.7±0.9	44.3±1.0	41.9±0.9	p<0.001	p<0.05



Direction of changes in ventilatory equivalent for oxygen and carbon dioxide in young males with different levels of physical load tolerance

cle ergometer test did not exceed 0.93±0.01, while in the low load tolerance group the RQ values increased to 0.92±0.01 in the 2nd minute of testing and to 1.07±0.01 in the 3rd one. The increase in RQ above 1 unit was due to the shift in the VCO_2/VO_2 ratio caused by the anaerobic production of excess CO_2 [4], which was typical of Group 1 in the 3rd minute of testing. In the group of young males with the high motor activity, VO_2 reached significantly higher values in the 3rd minute of testing against the lower VCO_2 values relative to Group 1. According to Wasserman et al. [6], RQ can be used as a measure for reaching the anaerobic (ventilatory) threshold in the case the value exceeds 0.95, which was characteristic of the moderate motor activity group in-between the 2nd and 3rd minutes of testing and indicated the strengthening of the anaerobic nature of the metabolic processes. The anaerobic threshold rate, in the authors' opinion, serves as a reliable marker of the aerobic fitness level for athletes and amounts to 45-60% of a predictive maximum of VO_2 [4]. In general, the data obtained in the young males from both groups showed that the change in VO_2 directly correlates with the time of performance of physical loads.

The figure illustrates the dynamics of changes in VCO_2 and VO_2 in the baseline and in the 2nd and 3rd minutes of the cycle ergometer test. It is known that the point of intersection of the VCO_2 and VO_2 curves are commonly referred to as a V-slope, where V-slope is the first point of departure from linearity of carbon dioxide output (VCO_2) plotted against oxygen uptake (VO_2) [6], which, according to the authors, is also associated with the start of the anaerobic metabolism and, hence, achievement of the anaerobic threshold. The figure illustrates that the point of intersection of the VCO_2 and VO_2 curves in the low load tolerance group was observed between the 2nd and 3rd minutes of testing, while in the high load tolerance group the VCO_2 and VO_2 curves did not intersect at all.

Similar information on the achievement of the anaerobic (ventilatory) threshold can be obtained from the analysis of the dynamics of VE/VCO_2 and VE/VCO_2. In the works by foreign authors, an increase in VE/VO_2 without a corresponding increase in VE/VCO_2, which was typical of the young males with the average level of motor activity in the 3rd minute of testing, is considered to be the criterion for reaching the anaerobic threshold [6].

Thus, in the 3rd minute of testing, the young males with the average level of motor activity were characterized by higher values of $FETCO_2$ and $FETO_2$ as compared to those with the high level of load tolerance. The detected differences indicated that in Group 1, the changes in the capillary gas exchange were associated, on the one hand, with the decrease in the oxygen consumption, and on the other hand - with an increase in the metabolic carbon dioxide extraction at the ventilatory threshold. The test data showed that O_2UC was significantly lower in the subjects with the average level of motor activity. Given that the respiratory minute volume was virtually the same in both study groups, we may suggest an increase in oxygen diffusion between alveolar air and blood and an improvement in the oxygen transport function in the young males from Group 2, which was consistent with the statistically lower $FETO_2$ values in the 3rd minute of the cycle ergometer test.

Conclusions. The study data showed that throughout the experiment, the heart rate values were statistically higher in the young males from Group 1. Moreover, the chronotropic load efficiency testified to the increase in the heart rate response by 28%, which indicates uneconomic cardiovascular system functioning in response to the functional test. The young males from Group 2 were characterized by the high tidal volume rate, which provided the optimal level of pulmonary ventilation in the 2nd minute of testing: it exceeded that in the moderate motor activity group by 19%. Proceeding from the analysis of the dynamics of changes in the studied indicators, we may conclude that the moderate motor activity group of young males reached the anaerobic thresh-

old between the 2nd and 3rd minutes of testing, while the high motor activity group never reached the anaerobic threshold.

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Psychophysiological features of ballroom dancers with different somatotypes

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Abstract

Objective of the study was to assess the impact of dance sport classes on the main morphofunctional and psychological characteristics of girls engaged in ballroom dancing.

Methods and structure of the study. A total of 65 adolescent girls from St. Petersburg school No. 204 were sampled for the study: Experimental Group - 35 subjects, Control Group - 30 subjects. The girls' motor mode was characterized as traditional (two Physical Education classes per week). Their somatotypes were evaluated by the Heath-Carter somatotype evaluation method. The Spielberger-Hanin test was used to identify the subjects' levels of trait and state anxiety. The adaptive potential of the circulatory system was determined based on the index of functional changes.

Results and conclusions. Based on the morphofunctional indicators reflecting the peculiarities of functional mechanisms during the bodily adaptation, the authors were able to determine the level of the subjects' adaptive potential, as well as the indicators of the level of functional and psychological fitness of young dancers. It was found that girls with different somatotypes have different levels of anxiety, motor activity, and adaptive potential.

As opposed to the Control Group girls, those engaged in ballroom dancing had a state of emotional stability, low levels of trait anxiety and psychosocial tension. The Experimental Group girls with the mesomorphic somatic type were found to have minor functional changes, and average levels of the state and trait anxiety, which indicated a high level of adaptive capabilities.

Keywords: *adaptive potential, psychoemotional state, somatotype, young athletes, dance sport.*

Background. A body type, or somatotype, is a fundamental feature of human body constitution. The somatotypological characteristics make it possible to forecast person's mobility and personal characteristics. Changes in the emotional state and anxiety level are a significant component of the adaptation process [3, 5]. The scientific research data show all sports activities that imply a high level of motor and psychological complexity place high demands on athletes, requiring from them the best adaptive response, in the structure of which the psychophysiological status is key [1, 7, 6].

Objective of the study was to analyze the impact of dance sport practices on the main morphofunctional and psychological features of female ballroom dancers.

Methods and structure of the study. Sampled for the study were 65 adolescent girls. The Experimental Group (EG) was made of 35 girls engaged in ballroom dancing, the Control Group (CG) – of 30 girls studying at the secondary school No. 204 of St. Petersburg, whose motor mode was characterized as traditional (2 physical education classes a week).

The girls' somatotypes were evaluated using the Heath-Carter method. Their state and trait anxiety levels were assessed by the Spielberger-Hanin test. Based on the index of functional changes, we deter-

Table 1. *Classification of functional states by the level of adaptive potential of the circulatory system*

Index of Functional Changes value, points	Functional state of the circulatory system	Level of adaptation
<2.59	Adequate	Good
2.60-3.09	Tension state	Satisfactory
3.10-3.49	Decreased	Poor
>3.49	Sharply decreased	Failure in adaptation

Table 2. *Level of adaptive potential in the representatives of different somatotypes, M±m*

Body type	Index of Functional Changes, points (M±m)	Functional state of circulatory system and adaptation level
Mesomorphic	1.97±0.12	Adequate, good adaptation level
Ectomorphic	2.65±0.008	Functional tension, satisfactory adaptation level
Endomorphic	5.091 ±0.02	Sharply decreased, failure in adaptation

mined the adaptive potential of the circulatory system.

Index of functional changes = 0.018•HR + 0.014•SBP + 0.008•DBP + 0.014•age + 0.009 •body mass - 0.009•body length - 0.27 [4].

Index of functional changes is the parameter that is inversely proportional to the level of adaptive potential (Table 1).

Results and discussion. The analysis of the anthropometric data by the Heath-Carter method revealed that the largest number of participants belonged to the mesomorphic body type (64.3%), 28.6% - the ectomorphic body type, and 7.1% - the endomorphic one.

The evaluation of the state and trait anxiety levels in the CG showed that these indicators in the EG were lower than in the CG. The high levels of the state and trait anxiety in the CG were due to the emotional excitement and attention failure. The CG girls (72%) were found to have a high trait anxiety level. The results obtained indicated that the participants were prone to various forms of neurotic conflict. In the EG, 7% of the trainees had a high state anxiety level, while the majority of the participants had average levels of the trait and state anxiety, indicating their emotional stability. The female athletes demonstrated an adequate response to different types of emotional tension, as well as a good motivational assessment of the situation.

The M. Luscher Color Test showed that the color preferences in the EG (75%) were as follows: blue, green, yellow. The majority of the CG girls (60%) were generally focused on a darker color scheme: gray, brown. Therefore, the CG subjects had a high level of psychological disadaptation. According to the literature sources, this is seen as a reaction of shifting away from social intercourse, tension, fatigue, low mood, need for rest [4].

The study found that with the gain in the training and competitive experience in dance sports, the psycho-emotional tension in adolescence is reduced.

The analysis of the adaptive potential of the circulatory system of the ballroom dancers revealed that the majority of the girls (57.2%) had a satisfactory level of adaptation. This indicated an adequate functional state of their circulatory system [2].

It was also found that 28.6% of the ballroom dancers were in stress, while the functional state of 7.1% of the subjects was characterized as poor, they demonstrated the early signs of failure in adaptation.

The somatotype and index of functional changes in the EG were closely associated. The girls with the mesomorphic body type were found to have the lowest index of functional changes, which indicated that these subjects had a high level of adaptive potential of the circulatory system (Table 2).

The study found that the index of functional changes in the EG subjects aged 12-15 years ranged from 2.60 to 3.09, thus indicating a state of functional tension. At the same time, the girls with the endomorphic body type were tested with the high index of functional changes, which indicated a sharply decreased functionality of the circulatory system, failure in adaptation.

Conclusion. The identified morphofunctional and psychological features of the body can be applied in the development of the constitutional model characteristics of young female ballroom dancers. This im-

plies the possibility of positive adaptation to dance sport practices and achievement of the highest competitive results.

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Hearing-impaired academic rifle shooting sport: self-suggestion with ideomotor training model for competitive progress

UDC 37.042

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Abstract

Objective of the study was to test and analyze benefits of a new self-suggestion with ideomotor training model for academic hearing impaired rifle shooting sport

Methods and structure of the study. We sampled for the purposes of the study (run in November 1, 2018 to November 1, 2019) the hearing impaired students (n=18), 2 Physical Education teachers and 5 rifle shooting instructors of the Bauman Moscow State Technical University's Physical Education Department, including an Honored Master of Sports (n=1), World Class Masters of Sports (n=2), Masters of Sports (MS, n=7) and Candidate Masters of Sports (n=8). The sample was split up into Experimental and Reference Groups (EG, RG) of 9 people each. The sample used air rifles, modern shooting equipment and accessories, SCATT shooting simulators equipped with laptops, and Record-10 targets. The tests were run under control of the coaches and instructors who recorded the training and competitive shooting scores and individual training progress for further analysis.

Results and conclusion. The new self-suggestion with ideomotor training model was tested beneficial as verified by the competitive shooting stability progress of 4 points in the EG versus 2 points in the RG; and the significant stabilization of the heart rate in the EG as a sound basis for progress in trainings and competitions. Based on the experimental data and analysis, we have grounds to recommend the new self-suggestion with ideomotor training model for application in the academic hearing impaired rifle shooting sports for progress in mental control and stress tolerance in trainings and competitions.

Keywords: *self-suggestion with ideomotor training model, rifle shooting, hearing-impaired academic shooters, mental and physical training.*

Background. Mental stress tolerance in modern sports is known to directly depend on the individual natural stress sensitivity [6], with mental stress control skills being particularly critical for the hearing impaired athletes exposed to special stressors due to, among other things, hampered responses to the coach's commands [2, 5, 6]. Study reports on the subject offer a wide range of special mental control and conditioning systems; whilst the self-suggestion with ideomotor training tools in application to the hearing impaired athletes, as we believe, deserve special interest and studies to analyze their potential benefits [1].

Objective of the study was to test and analyze benefits of a new self-suggestion with ideomotor training model for academic hearing impaired rifle shooting sport.

Methods and structure of the study. We sampled for the purposes of the study (run in November 1, 2018 to November 1, 2019) the hearing impaired students (n=18), 2 Physical Education teachers and 5 rifle shooting instructors of the Bauman Moscow State Technical University's Physical Education Department, including Honored Master of Sports (n=1), World Class Masters of Sports (n=2), Masters

of Sports (n=7) and Candidate Masters of Sports (n=8). The sample was split up into Experimental and Reference Groups (EG, RG) of 9 people each. The sample used air rifles, modern shooting equipment and accessories, SCATT shooting simulators equipped with laptops, and Record-10 targets. The tests were run under control of the coaches and instructors who recorded the training and competitive shooting scores and individual training progress for further analysis.

The self-suggestion with ideomotor training model includes a mental and physical training module with a perfect shot visualizing (ideomotor training) component. Before mastering the self-suggestion with ideomotor training basics with the self-control elements, the trainees were expected to understand logics of the following two key mental activation mechanisms. The first one implies words with the relevant senses and images being activated in a relaxed and mentally passive state close to a nap when the autonomic nervous system (that can hardly be controlled by conscious efforts) may be partially mobilized. And the second self-suggestion mechanism implies the ability to focus reasonably relaxed attention on what need to be done at the moment.

Furthermore, any business is known to require special attention, and the more attentive we are, the more successfully it goes with a higher efficiency rate. The self-suggestion with ideomotor training practices are normally run in recumbent posture with legs slightly apart, bent hands rested aside, with the head on a comfortable pillow. Alternatively, trainees may sit on the ground back to a chair or wall. And the third and more difficult posture is what I.G. Schultz, developer of the auto-suggestion method, called a coachman pose.

For the mental and physical training facilitation purposes, muscles are classified into five groups: (1) arms; (2) legs; (3) trunk; (4) neck; and (5) face [3, 4]. After the trainees have taken a comfortable posture and closed their eyes, the instructor will slowly and quietly verbalize the mental and physical training formulas with the trainees repeating them in mind trying to visualize every word in a specific vivid image. In a relaxing part of the mental and physical training session, the following verbal formulas may be used: I relax and calm down ...; My hands relax and warm up ...; My hands are completely relaxed ... warm ... motionless ...; My legs are relaxed and warm, etc. [1]. The deeper is the individual immersion in a dreamlike hypnotic state, the more pleasant and peaceful will be the feelings, with the trainee expected to memorize the mindset as a plane of comfortable color easily imaginable later on. The verbal formulas may also be used right before a training or shooting, with exception of the relaxing part of the mental and physical training. Prior to a shot, the shooter is recommended to visualize it making sure that the time costs of the mental exercise and actual shot are about the same.

In actual competitions, the perfect shot securing formulas may be verbalized in mind between the shooting rounds/ groups and in the rest breaks at the mental tuning times. The perfect shot formulas may include the following statements: “Great mood, eager to start”; “Actions come easy, confident”; “Legs are relaxed”; “Thigh goes up”; “Left hand off”, etc. In actual practice, such initial perfect shooting statements tend to shorten with time, with the least efficient screened out, and the remaining cemented in a few fast forms. In the practical self-suggestion with ideomotor training model testing experiment, the original 14 perfect shot formulas were reduced to seven: “Left off”; “Right tight”; “Obedient finger”; “The front sight heavy”; “Freeze”; “Trigger”; and “Check”.

The training was started from the mental and physical training basics mastering stage. Every mental and physical training session consisted of the following three parts: relaxing part for everybody; individual perfect shot securing formulas; and a mobilizing part customizable as required by the specific goals. Individual progresses in the self-suggestion with ideomotor training model testing experiment were rated using the following criteria: shooting stability in trainings and competitions (average shooting scores); and shooting heart rate versus the standard.

Results and discussion. Individual and group progresses in the self-suggestion with ideomotor training model testing experiment were rated using the above test criteria: see Table 1 hereunder.

As demonstrated by the above, the pre-experimental shooting stability rates in the EG and RG were virtually the same at 577 and 578 points, respectively,

Table 1. *Hearing-impaired rifle shooters’ progresses in the self-suggestion with ideomotor training model testing experiment*

Tests	Pre-experimental		Post-experimental	
	RG	EG	RG	EG
VP-60 shooting stability in trainings, points	577	578	579	582
VP-60 shooting stability in competitions and tests, points	577	576	579	583
Heart rate, beats per min	87-97	87-97	86-96	84-86

whilst the post-experimental tests found progresses of 4 and 2 points, respectively.

Conclusion. The new self-suggestion with ideomotor training model was tested beneficial as verified by the competitive shooting stability progress of 4 points in the EG versus 2 points in the RG; plus the meaningful stabilization of the heart rate in the EG as a sound basis for progress in trainings and competitions. Based on the experimental data and analysis, we have grounds to recommend the new self-suggestion with ideomotor training model for application in the academic hearing impaired rifle shooting sports for progress in mental control and stress tolerance in trainings and competitions.

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New physical training and health improvement model for university students based on physicality and functionality tests

UDC 796.01

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Abstract

Objective of the study was to design, based on the students' physicality and functionality tests, and test benefits of a new special health group-specific physical training and health model.

Methods and structure of the study. We sampled the 17-18 year old students of the St. Petersburg Polytechnic University's Institute of Mechanical Engineering, Materials and Transport ((n=148) and Institute of Computer Science and Technology (n=64), and used the standard medical examination reports to qualify them for the special health groups for academic Physical Education service. The physical development of the sample was rated by the traditional anthropometrics method, functionality tests and physical fitness tests versus the age- and gender-specific standards. The group physical training and health service was customized to the nosological groups (diagnoses).

Results and conclusion. Based on the entrance medical examination reports, most of the unhealthy sample was attributed to special health groups. The 17-18 year old sample was generally tested within the age- and gender-specific standards albeit low physical fitness and functionality test rates. The special health group sample was trained as required by the new physical training and health model of our design customizable to the actual somatic health issues – and the post-experimental tests found the model being beneficial as verified by the significant progress of the girls and boys special health groups in the physicality and functionality tests – versus the traditionally trained control special health groups that demonstrated poorer progresses in the tests.

Keywords: *tests, physical fitness indices, university students, age- and gender-specific standards, correction.*

Background. The national health experts are concerned by the falling somatic health standards of the university entrants due to both the hereditary factors and diseases rooted in the secondary school education period [1, 6, 7]. The students' daily physical activity is reported varying far under the physiological health norm with the relevant negative effects on the bodily functionality and natural protection mechanisms. Multiple health studies have found the unhealthy student population growing for the last decade up to 30.0% of the total [4, 5].

Objective of the study was to design, based on the students' physicality and functionality tests, and test benefits of a new special health group-specific physical training and health model.

Methods and structure of the study. We sampled the 17-18 year old students of the St. Petersburg Polytechnic University's Institute of Metallurgy, Mechanical Engineering and Transport (n=148) and Institute of Computer Science and Technology (n=64), and used the standard medical examination reports to qualify them for the special health groups for academic Physical Education service complemented by a new physical training and health model. The physical development of the sample was rated by the traditional method of anthropometrics, functionality tests and physical fitness tests versus the age- and gender-specific standards. The group physical training and health service was customized to the nosological groups (diagnoses) [8, 9, 11].

Most of the sample was diagnosed with the musculoskeletal and vision system disorders, in compliance with the data reported by other studies [10]. The sample anthropometric characteristics were found matching within the age- and gender-specific standards (see Table 1), although the heart rate test data were found in excess (by 31.7%) of the standard, whilst the carpal strength tests rates varied within the low age- and gender-specific range.

Furthermore, we used a set of physical fitness tests to rate the physical qualities and physical working capacity: see Table 2. The physical working capacity was rated by the aerobic endurance rating Ruffier test and found the actual physical working capacity 5 and 4 times lower than the age- and gender-specific standard for the girls and boys special health groups, respectively, i.e. falling within the low range. The coordination qualities rating simple motor response tests found the coordination qualities of the sample far below the age- and gender-specific standards.

The girls and boys groups were tested under the age- and gender-specific standards in the flexibility test (36.1% and 57.7% lower, respectively), speed-strength endurance of the upper abs (44.6% and 56.6%, respectively) and lower abs (19.3% and 29.4%, respectively), and strength endurance of the shoulder girdle (31.2% lower in the boys group).

We grouped the sample on the diagnosis- and gender-specific basis into the special health groups to test the new physical training and health model complementary to the academic elective Physical Education curricula (see Table 3) versus the traditionally trained control special health group [2, 3].

Results and discussion. The new special health group physical training and health model tests for the academic year showed significant ($p \leq 0.05$) progress in the tested physical qualities and physical working capacity; with the particularly high progress achieved by the special health group girls in the following tests: musculoskeletal system – in physical working capacity (50.0% growth), coordination (27.5% growth); vision – flexibility (30.4%) and lower abs strength (28.5%) tests; and cardiovascular system - in the lower abs strength (35.7%) and physical working capacity (30.9%) tests. And the special health group boys were tested with the following progress: musculoskeletal system – in the flexibility and coordination (54.5% and 28.4% growth, respectively) tests; vision - in the lower abs strength and coordination (47.0% and 44.2%, respectively) tests; and the cardiovascular system – in the lower abs strength and flexibility

Table 1. *Physical development and functionality test rates of the special health group student sample*

Tests		Girls, n=161	Boys, n=180
		± σ	± σ
Body length, cm		167 ± 5,6	178 ± 6,6
Body mass, kg		56,6 ± 8,1	71,8 ± 6,6
Body mass index,		20,2 ± 3,0	22,5 ± 5,9
Systolic blood pressure		116 ± 13	126 ± 14
Diastolic blood pressure		77 ± 10	77 ± 10
Pulse pressure		39,4 ± 8,7	49 ± 8,5
Resting heart rate, beats per min		89 ± 16	84 ± 12
Vital capacity, ml		3634 ± 452	4617 ± 814
Carpal dynamometry	Right	30,6 ± 7,6	45,2 ± 11,8
	Left	26,9 ± 7,4	42,7 ± 9,7
Hypoxic tolerance, s	Stange test	43 ± 14	51 ± 18
	Genche test	27 ± 9	30 ± 13

Table 2. *Physical fitness test data of the special health group sample*

Tests		Girls, n=161	Age- and gender-specific standard	Boys, n=180	Age- and gender-specific standard
		± σ		± σ	
Physical working capacity		15,2 ± 7,9	0-3	11,5 ± 5,3	0-3
Flexibility, cm		11,5 ± 7,8	18	5,5 ± 9,4	13
Coordination qualities, cm		13,8 ± 4,2	0	14,7 ± 5,6	0
Speed-strength endurance	Upper abs	17 ± 4	45	22 ± 5	50
	Lower abs	14 ± 3	20	17 ± 3	30
	Dorsal muscles	28 ± 6	45	32 ± 8	50
	Shoulder girdle	17 ± 5	17	26 ± 11	32

Note: Speed-strength endurance of the shoulder girdle was rated by the prone push-ups test (plank and kneeled versions for the boys and girls, respectively)

Table 3. *Diagnosis- and gender-specific physical training and health model for special health groups*

Special health groups	Girls	Boys
Musculoskeletal system disorders	Classical and dance aerobics with adapted choreography, stretching	Strength training with/ without weights, Pilates, stretching
Vision system diseases	Low-intensity strength training, Pilates, stretching, yoga practices	
Cardiovascular system diseases	Cyclic treadmill practices, low-intensity classical aerobics	
	Fitball, Bosu practices, breathing gymnastics	Pilates, athletic gymnastics: Group 1, 3, 5 exercises
Respiratory system diseases	Yoga, stretching, Pilates, breathing gymnastics	Bodyflex, yoga, breathing gymnastics, kettlebell/ rubber belt practices

(35.3% and 32.7%) tests. The control group of students trained by the traditional method achieved the highest progress in coordination tests (with 27.5% and 21.4% growth in the girls and boys groups, respectively).

Conclusion. Based on the entrance medical examination reports, most of the unhealthy sample was qualified with the musculoskeletal disorders. The 17-18 year old sample was generally tested within the age- and gender-specific standards albeit low physical fitness and functionality test rates. The special health group sample was trained as required by the new physical training and health model of our design customizable to the actual somatic health issues – and the post-experimental tests found the model being beneficial as verified by the significant progress of the girls and boys special health groups in the physicality and functionality tests – versus the traditionally trained control special health group that demonstrated poorer progress in the tests.

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European football leagues: finacial and economic performance versus competitive ranking analysis

UDC 336.647.2

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Abstract

Objective of the study was to make a comparative analysis of the financial and economic management systems of the modern European Football Leagues to find the most efficient one.

Methods and structure of the study. The European Football Leagues subject to the comparative analysis herein were classified by the specific financing mechanisms. As far as free market corporate businesses are concerned, their performance efficiency is rated by mostly their profitability – whilst the sports industries, with their emphasis on the social service dimension, are still in need of reliable and transparent performance indicators. Many studies in this field have offered different sets of performance rating criteria, with varied subjectively ranked contributions to the consolidated performance rates. Based on analyses of the relevant research literature with concern to the economic processes in the modern sports industry and its strategic management issues, we developed a set of performance criteria applicable for the sports leagues' economic progress rating and analyzing purposes.

Results and conclusion. The study showed that the professional sports industry operates (conditional on a competent management, particularly in the brand name/ club/ league promotion, advertizing, clientele building, human resourcing, investment and innovation activity supporting and other elements) as a highly effective and profitable investment and advertising instrument with the potential high benefits both in the financial and image building domains, and with the relevant socio-economic progress aspects. These correlated financial and economic performance mechanisms in our country may be mobilized conditional on the significant growth of the private shareholding interests including households – that are known to account for 70-80% of the total revenues of the European Premier Leagues clubs, with these interests largely protecting the clubs from the risks associated with the budgetary-only funding of the sports industry.

Keywords: *football industry, financial and economic management system analysis, efficiency, integral performance rates.*

Background. Presently the national expert community acknowledges the need for an efficient professional sports financing and economic management system since the existing model dominated by the governmental budgetary and quasi-governmental sources largely fails to meet the new social standards, requirements and challenges. It may be beneficial in this context to have a variety of the sports financing and economic management models analyzed to find the most efficient one.

Objective of the study was to make a comparative analysis of the financial and economic management systems of the modern European Football Leagues to find the most efficient one.

Methods and structure of the study. The European Football Leagues subject to the comparative analysis herein were classified by the specific financing mechanisms. As far as the free market corporate businesses are concerned, their performance efficiency is rated mostly by their profitability – whilst the sports industries, with their emphasis on the social service dimension, are still in need of reliable and transparent performance indicators. Many studies in this field have offered different sets of performance rating cri-

teria, with varied subjectively ranked contributions to the consolidated financial and economic performance rates. Based on the study of the relevant research literature with concern to the economic process in the modern sports industry and its strategic management issues, we developed a set of performance criteria applicable for the sports leagues' financial and economic performance rating and analyzing purposes.

The corporate progress criteria found by the critical analysis may be classified into the following financial and economic performance rates: incomes; costs; capital structure; payroll to the total revenue ratio; net debt; equity to debt ratio; net profit and loss; and trade balance for transfers. These financial and economic performance rates, on the one hand, include the performance rates prioritized by UEFA [14] as indicative for the Football League financial situation; and on the other hand, make it possible to rate every football club management efficiency – to provide inclusive and comprehensive measures for the Football League financial and economic performance analyses.

The financial and economic performance rates need to be first of all weighted and ranked for the financial and economic performance efficiency analysis. Based on the uncertain multitudes theory, we used the Fishburne test that rates the weight criterion decrease versus the next criterion, with every index quantified as follows:

$$r_i = (2(N-i+1)) / ((N+1)*N), \quad (1)$$

where i is the index number; ri is the specific value of each i-th index; and N is the total number of indices.

Based on the expert valuations of the financial and economic performance rates, we ranked the indices and their weight: see Table 1. Weights of the indices were factored in to produce an integral financial and economic performance index as follows [9]:

$$Ifp = \sum(rt *(\sum rij*NDij))+\sum(rt *(rij*NRij))+\sum(rt *(rij*NSij)) +\sum(rt *(rij*NPij)), \quad (2)$$

where Ifp is the integral financial and economic performance rate of the football league; rt is the general weight of the i group of performance rates; rij - weight of specific index; NDij – "income" group stand-

Table 1. *Ranked and weighted financial and economic performance rates*

Financial and economic performance elements	Rank	Total weight, rt	Financial and economic performance rates (Nij)	Rank (ij)	Weight(rij)
Incomes (ND)	1	0,4	Core business incomes	1	0,667
			Other incomes	2	0,333
Costs (NR)	2	0,3	Payroll to income ratio, %	1	0,667
			Other costs	2	0,333
Capital structure (NS)	4	0,1	Net debt	1	0,500
			Equity	2	0,333
			Debt	3	0,167
Efficiency rates (NP)	3	0,2	Net profit	1	0,667
			Trade balance for transfers	2	0,333

Table 2. *European Football Leagues ranked by their consolidated financial and economic performance rates (Ifp)*

Football Premier Leagues	2015	2016	2017	2018	Average
England	1 880,2	2 050,9	2 257,7	2 360,3	2 137,28
Spain	872,2	1 052,0	1 236,9	1 366,1	1 131,80
Germany	917,5	1 018,8	1 062,4	1 205,4	1 051,03
Italy	836,6	885,6	989,3	1 011,7	930,80
Russia	284,6	268,0	301,0	281,1	283,68
Portugal	211,0	207,3	259,5	244,8	230,65
Netherlands	184,9	195,7	221,8	209,6	203,00
Belgium	131,7	152,5	171,1	172,5	156,95
Denmark	64,6	87,8	81,2	84,4	79,50
Croatia	27,2	32,3	25,7	31,3	29,13

ards; NRij – "cost" group standards; NSij – "capital structure" group standards; and NPij is the "efficiency rating" group standards. The financial and economic performance model uses a standard set of financial and economic performance indices weighted with account of their implied significance rate – to produce a consolidated financial and economic performance rate of the football league.

Results and discussion. We used formula 1 and expert valuations of the financial and economic performance criteria to rank and weight up the financial and economic performance rates: see Table 1.

We used the above ranked and weighted financial and economic performance rates to calculate the integral (consolidated) financial and economic performance rates for the European Football Leagues: see Table 2.

The English Premier League was ranked on top of the financial and economic performance and financial sustainability scales with its high payrolls making it possible to contract the best footballers, keep up the interest of supporters and generate great incomes from the sponsorship and broadcasting contracts. Ranked on top are also the Spanish, German and Italian Premier Leagues that are still less economically successful than the English Premier League although highly popular in their countries and the world over and, hence, generating significant cash flows for progress. Given of Figure 1 hereunder are the Premier League progress rates (highlighted ellipses) in a two-dimensional system. The English Premier League shows the best progress (green ellipse in quadrant 2000-250). Quadrant 1000-1500 indicates modest but stable progresses of the Spanish, German and Italian Premier Leagues. And the other Premier Leagues lag behind on the progress chart due to their limited resource on the target service markets.

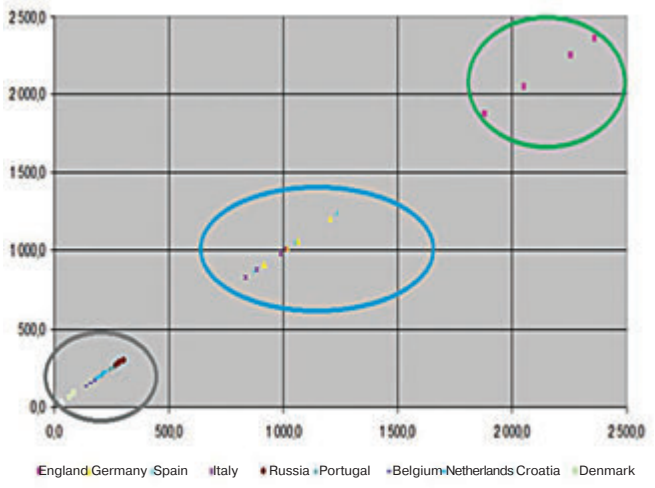

Figure 1. *European Football Leagues ranked by financial and economic performance progress, consolidated Ifp rate*

It may be pertinent to consider, for the purposes of the study, correlations of the Football Leagues competitive and financial and economic performance elements. Given on Figure 2 hereunder are the competitive rankings (UEFA rankings for the 2015-2018 period) versus Ifp, with the correlation ratio computed using formula 4. The correlation ratio was found to be highest for a logarithmic dependence. Basic correlation between the two Ifp variables and the UEFA rankings for 2015-2018 was computed as follows:

$$Y = a \ln x + b, \quad (3)$$

where Y is the Football League competitive ranking to financial and economic performance correlation ratio; a – is the meaning/ elasticity) of the dependent variable; x – clubs' financial performance; and b is the random variable.

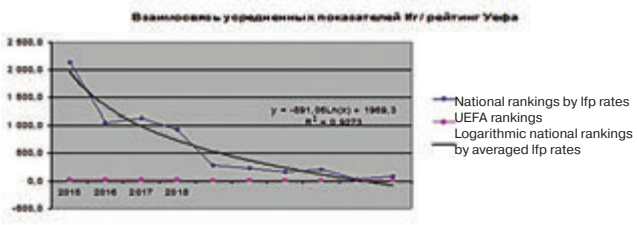

Figure 2. *UEFA competitive ranking to averaged Ifp correlation ratio*

Given in Table 3 hereunder are the annual numerical UEFA competitive rankings to averaged Ifp correlation ratios.

Table 3. *Annual UEFA competitive rankings to averaged Ifp correlation ratios*

Year	2015	2016	2017	2018	Average
R_2	0,94	0,91	0,77	0,85	0,87

The above table demonstrates a close correlation between the UEFA competitive ranking and financial and economic performance – that is only natural since the football clubs incomes directly depend on their competitive activity and successes i.e. grow with the competitive progress. The above regression equations show that a 100% growth in the Ifp rate will result in the UEFA ranking going up 10 times on average. Influences of the analyzed variables may be rated more accurately using the elasticity ratio indicative of the actual correlation of a Football League competitive ranking with the Ifp rate. The elasticity ratio was estimated to vary within the range of 10-15 points – that means that a 1% variation in Ifp rate will result in the UEFA ranking changing by at least 10%. This means that the financial performance rate (Ifp) is of special influence on the Football League ranking.

Conclusion. The English Premier League financial and economic performance analysis showed that the professional sports industry operates as a highly effective and profitable investment and advertising instrument with the potential high benefits both in the financial and image building domains, and with the relevant socio-economic progress aspects. These correlated financial and economic performance mechanisms in our country may be mobilized conditional on the significant growth of the private shareholding interests including households – that are known to account for 70-80% of the total revenues of the English Premier League clubs, with these interests largely protecting the clubs from the risks associated with the budgetary-only funding of the sports industry.

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Modular training course of elective academic aerobics

UDC 378.147

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Abstract

Objective of the study was to develop and test benefits of a new modular training course of academic elective aerobics

Methods and structure of the study. The new modular training academic aerobics course offers a system of training modules and their elements with the relevant hierarchical missions and goals geared to form the target theoretical competences and practical skills in the discipline. We sampled for the study the Peter the Great Saint Petersburg Polytechnic University's students (n= 276) trained at elective aerobics course to test benefits of the new modular training model.

Results and conclusion. The hierarchical module structure of the modular training course is geared to facilitate the training progress with fast adaptation to aerobics trainings based on focused learning with expansion of the theoretical knowledge and practical skill sets, and with a special emphasis on the individual independence, creativity, teamwork, constructive climate in the team for successful cooperation and progress of every trainee. The progress test module is designed to profile the individual progress paths at every educational service stage using a progress test and scoring system. We used in our study a set of the personal progress rating criteria of our own design, with the progress rated using a set of special scoring tables. The new modular training aerobics course with the relevant informational service and progress facilitating provisions designed to complement the standard elective academic aerobics curricula was tested beneficial as verified by the sample progress in the physical fitness and functionality rating tests and practical accomplishments in the discipline.

Keywords: *aerobics, modular training course, training module, physical fitness, functionality, physical education, educational service, learning materials.*

Background. The training technology with a modular curriculum and learning process in the physical education domain may be defined as the system designed to simultaneously form the necessary knowledgebase, skills and abilities for the target learning, training and independent practical service [2, 8]. Modern professional educational system makes a transition to the modular educational technologies with a special priority to efficient cooperation of the educational service actors [1, 4, 5]. Such an educational service implies a specific educational algorithm with predominantly homogeneous content governed by the psychological, pedagogical and physiological logics of the modern physical education service, with the educational service models designed to systematically mobilize the students' learning resources for success of the learning process [3, 4, 6]. The study was designed to respond the growing need for modern educational service methods and tools in the elective academic aerobics discipline.

Objective of the study was to develop and test benefits of a new modular training course of academic elective aerobics

Methods and structure of the study. The new modular training academic aerobics course offers a

system of training modules with their elements including the relevant hierarchical missions and goals geared to form the target theoretical competences and practical skills in the discipline. Every training lesson may be described as a mini-module with its elements interrelated and integrated so as to ensure the educational service integrity, continuity and completeness, with the physical training goals harmonized with the cognitive ones. The modular training technology in every such class uses a specific action algorithm to attain specific goals and integrate the relevant mission, targets, learning materials, informational service, practical support tools and the progress test system.

The hierarchical modular structure of the learning materials is geared to facilitate the training progress and fast adaptation to aerobics trainings based on focused learning with expansion of the theoretical knowledge and practical skill sets, and with a special emphasis on the individual independence, creativity, teamwork, constructive climate in the team for successful cooperation and progress of every trainee. The progress test module is designed to profile the individual progress paths at every educational service stage using a progress test and scoring system. We used in our study a set of the personal progress rating criteria of our own design, with the progress rated using a set of special scoring tables [6].

Results and discussion. Physical fitness tests in the study were designed to profile progress in the core physical qualities. We fixed the individual best results in the following physical fitness tests: 30s prone push-ups test to rate speed-strength; sit-up and bend test to rate strength endurance; bench standing front leans tests to rate flexibility; and a falling ruler catch test to rate response. Note that 84% of the sample made progress in the tests for the experimental period: see Table 1.

Table 1. *Average pre- and post-experimental physical fitness test rates, on a 5-point scale*

Tested qualities	Pre-experimental	Post-experimental
Speed-strength	3,4 ± 0,4	4,0 ± 0,2
Strength endurance	3,6 ± 0,3	4,2 ± 0,2
Flexibility	2,9 ± 0,2	3,2 ± 0,3
Response rate	3,4 ± 0,3	3,9 ± 0,4

Furthermore, we tested the cardiovascular system functionality to profile the individual adaptations to the training workloads by the following tests: resting heart rate test; 20 squats for 30s test to rate the cardiovascular system recovery qualities; and Ruffier indices: see Table 2.

Table 2. *Average pre- and post-experimental functionality test rates, on a 5-point scale*

Tested functions	Pre-experimental	Post-experimental
Resting heart rate	3,7 ± 0,2	3,7 ± 0,3
Endurance	2,5 ± 0,3	3,2 ± 0,2
Recovery rate	3,9 ± 0,3	4,3 ± 0,5
Ruffier index	2,8 ± 0,2	3,1 ± 0,3

Benefits of the new modular training service were also rated by a questionnaire survey of the trainees: see Figure 1.

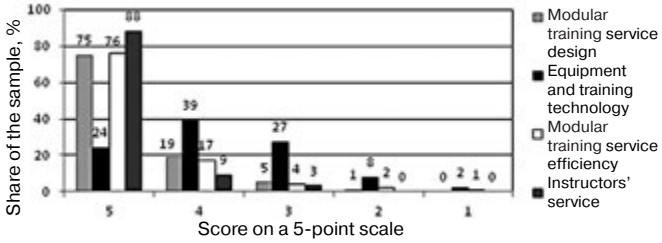

Figure 1. *New modular training aerobics course benefits rated by the trainees*

We found 75% of the sample rating the modular training model design by the top 5 points i.e. highly appreciating its efficiency; and 88% of the sample rated high the instructors' service for its professionalism, competency, communication skills and special interest.

The new modular training course gives a high priority to the independent/ self-reliant learning in different forms often supported by some necessary prior guidance from instructors or fully independent, with or without prior instructions [2, 7]. We made an analysis of the sample progress in the independent learning and practical training domains – and found significant progress on the theoretical and practical progress rating scales: see Figure 2.

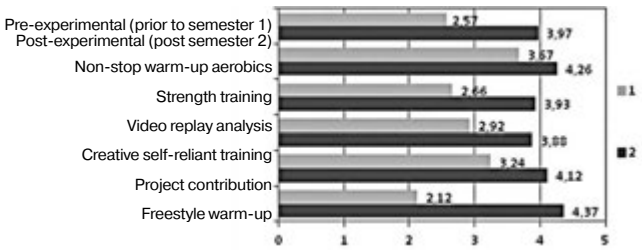

Figure 2. *Average independent training progresses of the sample in the new modular aerobics training course*

On the whole, the sample progress tests found the new modular aerobics training course facilitating the self-reliant creative progress of the trainees in many

domains including the personality progress agendas and cognitive development.

Conclusion. The new modular training aerobics course with the relevant informational service and progress facilitating provisions designed to complement the standard elective academic aerobics curricula was tested beneficial as verified by the sample progress in the physical fitness and functionality rating tests and practical accomplishments in the discipline.

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Mass race competitors' motivations and values: questionnaire survey and analysis

UDC 796.034

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Abstract

Objective of the study was to survey and analyze the key competitive and sporting motivations and priority values of the Cross of Nations mass race competitors.

Methods and structure of the study. We sampled active Cross of Nations mass race competitors (n=113) for a questionnaire survey and classified them by the competitive experiences into the Newcomer, Occasional and Habitual Groups. Gender, age and social status analysis made it possible to profile the active competitors and rate and analyze in this context their key motivations, priority values and sporting agendas.

Results and conclusion. The survey data and analyses found the Cross of Nations mass race competitors' motivations and priority values varying in a wide range, with the survey data being of special importance for the event organizing and management service and mass participation encouragement initiatives. The survey found the mass race competing experiences being virtually uncorrelated with the individual sporting motivations of the sample, although somewhat correlated with the priority values. The service satisfaction survey found more than half of the sample happy with the event organization and management service – that means that the event has made good progress and has a vast potential for further popularity.

Keywords: *Cross of Nations, mass race competition, competitive motivations and priority values, service satisfaction survey, questionnaire survey*

Background. Modern mass race competition and health racing sport on the whole are ranked among the most efficient popular physical education/ health encouragement initiatives – that need to be supported by sound information about the relevant popular key sporting motivations and priority values, attitudes and service satisfaction surveys to have the events customized to all these factors [1, 5]. The mass-race-competition-specific motivations and priority values of different population groups are of growing interest for the sport research community [2-4, 6], and the research data in its turn are considered highly beneficial for the event organizers and movement leaders for the service customization and popular interest and support encouragement purposes.

Objective of the study was to survey and analyze the key competitive motivations and priority values of the Cross of Nations mass race competitors.

Methods and structure of the study. We sampled active Cross of Nations mass race competitors (n=113) for a questionnaire survey and classified them by the competitive experiences into the Newcomer, Occasional and Habitual Groups. Gender and age analysis found the Newcomer Group virtually gender equal and the Occasional and Habitual Groups dominated by men; with the 19-29 and 30-55 year-olds leading in the age structure. It should be noted that the 55+ year-olds were virtually non-represented in the sample. In the social aspect, the sample was dominated by the university/ college students and

Table 1. *Cross of Nations mass race competition competitive experiences versus the individual sporting agendas, %*

Sporting agenda	Newcomer	Occasional	Habitual
The Cross of Nations encourages my sporting lifestyle	13,5	–	2,7
Just tackled regular sports	–	12,5	5,4
Train from time to time	19,2	25,0	21,6
No influence from the Cross of Nations	67,3	62,5	70,3

Table 2. *Key motivations for the Cross of Nations mass race competition reported by the sample*

Motivation	Newcomer		Occasional		Habitual	
	%	Rank	%	Rank	%	Rank
Holiday atmosphere	28,8	1	29,2	1-2	13,5	4-5
Contribution to the major national sports event	19,2	3	12,5	4	13,5	4-5
Contacts with friends and teammates	17,3	4	25,0	3	21,6	2
Pleasure to run well-organized and served race	13,5	5	8,3	5	16,2	3
Test my fitness for the GTO Complex tests	11,5	6	–	–	10,8	6
Active rest and fun outdoors	25,0	2	29,2	1-2	24,4	1
Other	–		–		–	

employed individuals, with most of the sample reporting no other sports in their preferences.

Results and discussion. Given in Table 1 are the survey data that generally show the sporting agendas of the sample being non-correlated with their competitive records, as approximately one of five respondents in every group going in for sports on an occasional basis – from time to time.

The survey data given in Table 2 show a wide variation of individual motivations and priority values for Cross of Nations and sports on the whole.

The survey data found every respondent being motivated for the event, with motivations different in a wide range although generally determined by the practical competitive experiences ('competing frequencies'). Thus the Newcomer and Occasional Groups underlined the 'holiday atmosphere" and the Habitual Group "active rest and fun outdoors" as their key motivations; with all the three groups equally appreciating the "contacts with friends and teammates" among the key motivations for joining the event.

Sporting dimension has been in a growing priority for the event organizers and competitors for many years of the racing movement for its benefits including the promotional contributions from the highly-skilled/professional sport celebrities to the events. This was the reason for us to find the sample attitudes to the sporting dimension of the Cross of Nations: see the survey data in Table 3.

As demonstrated by the above table, most of the sample was supportive of the Cross of Nations sporting dimension, with the Newcomer and Habitual Groups equally hoping to win the title or medal; and relatively small shares in every group striving to

Table 3. *Sporting dimension of the Cross of Nations mass race competition rated by the sample, %*

Rate	Newcomer		Occasional		Habitual	
Appreciation of the sporting dimension						
Yes, I like it	98,1		100		97,3	
No, it's unimportant for me	1,9		–		2,7	
What aspects of the sporting dimension are of special interest						
	%	Rank	%	Rank	%	Rank
Qualify for next class	13,5	2	–	4-5	2,7	3-5
Qualify for picked team	1,9	4	4,2	3	2,7	3-5
Win title or medal	78,8	1	50,0	1	78,4	1
Qualify for Master of Sports	–	5	–	4-5	2,7	3-5
Other	5,8	3	45,8	2	13,5	2

Table 4. *Cross of Nations organization and management service satisfaction survey data, %*

Rate	Newcomer	Occasional	Habitual
Happy with the service	28,9	29,2	32,5
Happy with some reservations	26,9	20,8	24,3
Uncertain	26,9	33,3	24,3
Unhappy with many aspects	15,4	16,7	18,9
Totally unhappy	1,9	–	–

qualify for the next sports class or a municipal picked team.

The survey was also designed to rate satisfaction of the sample with the Cross of Nations organization and management service. The service satisfaction data is of special importance for the event organizers since it is run on an annual basis. See the service satisfaction survey data in Table 4.

The service satisfaction survey found more than half of the sample happy with the event organization and management service, and only one of five respondents uncertain on the point.

Conclusion. The survey data and analyses found the Cross of Nations mass race competition competitors' motivations and priority values varying in a wide range, with the survey data being of special importance for the event organizing and management service and mass participation encouragement initiatives. The service satisfaction survey found more than half of the sample being happy with the event organization and management service – that means that the event has made good progress and has a vast potential for further growth and popularity.

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